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ARTICLE I.

On the Corundum Stone from Asia. By the Right Hon. CHARLES GREVILLE, *F. R. S**.

Analyfi cryftallorum, tam ejufdem quam diverfæ figuræ, multum lucis fcientia expectat.

BERGMAN, Opufc. de Terra Gemmarum.

HAVING contributed to bring into notice the mineral fubftance from the Eaft-Indies, which is generally called adamantine fpar, I beg leave to lay before the Royal Society the following account of its hiftory and introduction.

About the year 1767, or 1768, Mr. William Berry, a very refpectable man, and an eminent engraver of ftone, at Edinburgh, received from Dr. Anderfon, of Madras, a box of cryftals, with information of their being the material ufed by the natives of India to polifh cryftal, and all gems but diamonds. Mr. Berry found that they cut agate, cornelian, &c. but in his minute engraving of figures upon feals, &c. the fuperior hardnefs of the diamond appeared preferable; and its difpatch compenfated for the price: the cryftals were therefore laid afide as curiofities. Dr. Black afcertained their being different from other ftones obferved in Europe; and their hardnefs attached to them the name of adamantine fpar. My friend, Colonel Cathcart, fent me its native name, *Corundum*, from India, with fome fpecimens given to him by Dr. Anderfon in 1784, which I diftributed for analyfis.

When the native name was obtained, it appeared from Dr. Woodward's catalogue of foreign foffils, publifhed about the year 1719, that the fame fubftance had been fent to him by his correfpondent Mr. Bulkley.

In his firft catalogue of foreign foffils, p. 6. ζ. 17. "*Nella corivindum* is found in fields where the rice grows: it is commonly thrown up by field rats, and ufed, as we do emery, to polifh iron."

* Philofophical Tranfactions, 1798, p. 403.

Page 11. λ. 13. "*Tella convindum*, Fort St. George, Mr. Bulkley. 'Tis a talky ſpar, grey, with a caſt of green: it is uſed to poliſh rubies and diamonds."

In Dr. Woodward's Additional Catalogue of Foreign Foſſils, publiſhed in 1725, p. 6. ζ. 10. "*Nella corivendum* is found by digging at the foot, or bottom, of hills, about five hundred miles to the ſouthward of this place. They uſe it as emery, to clean arms, &c. it ſerves alſo to grind rubies, by making it like hard cement, by the help of ſtick lac mixt with it. Eaſt-India. Mr. Bulkley."—Theſe, with a few others in Woodward's Catalogues, are the only inſtances by which any author, prior to 1768, appears to have noticed this ſubſtance.

This information being unſatisfactory, and every appearance of the ſtone indicating it to be part of a ſtratum, I wrote repeatedly to friends in India, to aſcertain, if poſſible, the ſituation of the rock, and if near the ſea, to ſend a conſiderable quantity as ballaſt, with a view of applying it to cut and poliſh granites, porphyry, and other ſtones, which the high price of cutting and poliſhing excluded from uſeful or ornamental work. But my inquiries at Madras were fruitleſs: by ſome I was aſſured it came from Guzarat. From Bombay I obtained no ſatisfactory information. At laſt, in the year 1793, I obtained a ſatisfactory account. Sir Charles Oakley was diſpoſed to oblige me: he was then Governor of Madras; and his ſucceſs is due to the activity and judgment of Mr. Garrow.

Mr. Garrow knew how difficult it was to avoid the cauſes of my failure, from every Hindoo being occupied by the duties of his caſt; ſcarcely thinking on any thing elſe, and wherever his intereſt is concerned, being ſuſpicious and reſerved. Mr. Garrow, in the firſt place, aſcertained the caſt connected with corundum, to be the venders of glaſs *bangles*; that they uſed it in their buſineſs, and ſold it to all other caſts. This caſt of natives at all times had free acceſs to every part of Tippoo's country; nor until the diſtricts about Permetty were ceded to the Engliſh, could it be procured in any other way. Mr. Garrow depended on his perſonal inſpection; the particulars are contained in the following letter communicated to me by Sir Charles Oakley.

SIR CHARLES OAKLEY, BART.

"Sir, Tritchinopoly, 10th Nov. 1792.

"I derived ſo little ſatisfaction from the various accounts given me of the corundum, from the indifference of the natives to every ſubject in which they are not immediately intereſted, that I reſolved to aſcertain the particulars I wiſhed to know, on the ſpot where the ſtone is found. The glaſs-men agreed in one material circumſtance, that the place was not far from Permetty: in other particulars they diſagreed, apparently with intention to miſlead.

"It is near a fortnight ſince I diſpatched a ſervant I could depend on to Permetty, with one of theſe people, who on his arrival there, probably through fear of his caſt, ſaid he knew no farther. My ſervant perſevered, and informed me he had found the place I wiſhed to ſee.

"I arrived at Permetty, by the route of Namcul, the 6th; and learning that the diſtance to the ſpot was about 3½ hours, or 14 miles, I left Permetty in time to arrive there about ſunriſe the next morning. At this time no perſon but my ſervant was preſent, and from a continued excavation at different depths, from 6 to 16 feet, in appearance like a water-courſe, running

running in length about a mile and a half east and west over the brow of a very rising ground, I saw at once the place from which the stone was procured. The prodigious extent that at different times appears to have been dug up, with the few people employed, shews that it has been a business of ages.

"The ground on which the vein of excavation runs, and of course the mineral, commands one of the finest and most extensive prospects it is possible to conceive. The surface of the ground is covered with innumerable fine alabaster stones, and a variety of small shrubs, but not a tree sufficient to shelter my palanquin.

"There is not the appearance of an habitation within three quarters of a mile. The nearest village is called Condrastra Pollam. In this village are about 30 small thatched houses: among these are 5 families, who, in descent by prescriptive right, are the miners, and dig in the pits. The nearest place of any consequence in Rennel's Map, is Caranel, on the south side the Cavery. The distance of the pits from the river is above four miles; but the ground between prevents its being seen in a direct line. A fine view of the river is seen near Erode; which fort, as well as Sankerdroog, are plainly visible with the naked eye, as is also the Coimbitoor country, south and west of the river, to an immense extent.

"I procured at Permetty a cadjan, from the Bramin manager to the head man of the Pollam; which on my arrival at the pits I sent to him; and soon after three of the miners came from the Pollam, with their implements, and families following with provisions. As they came up they inquired of my servant how they were to address me, having never seen an European before.

"I followed them into a pit in the line of the excavation, above 14 feet from the ground level. The instrument they used is a very heavy iron crow, ending in a broad point, with a straight wooden handle clampt with iron. The soil they cut through is of different colours, but composed chiefly of a gritty granite; and at the depth of seven feet are layers of a substance not unlike dried pitch, which crumbles into small flakes when taken out. With considerable labour the miners, with the points of their crows, cut out several pieces of the strata, of some pounds weight each; and when a considerable quantity was broken off, it was carried up, and crushed to pieces with great force by the iron crow. Among these broken lumps the corundum stone is found; but in many of the pieces there was none. The mode of getting it, made it difficult to get any with the stratum adhering to it; this, however, after several trials, I obtained very perfect, and shall forward to Madras, with specimens of the strata at different depths. The stone is beyond all comparison heavier than the substance which encrusts it.

"It appears extraordinary how this stone, so concealed, should, under such difficulties, have been sought for, and applied to any purpose; and that the knowledge of the few people who dig for it, and who do so from father to son, is confined entirely to the finding the stone. For they told me they knew none of its uses, and that the labour was so hard, and their gain so small, that they would, through choice, rather work in the fields; that the sale of it, from the spot, is confined solely to the glass-sellers, who vend it over the whole country, and who had, while I was there, above forty Parriar horses, bullocks, &c. ready in the Pollam

Pollam to carry it to Tinnevelly, and the ſouthern countries; through which track, if the ſtone is known in Europe, I apprehend it has found its way by means of the Dutch.

" The people on the ſpot declare it is to be got in no other ſituation, or place, whatever; and the ſtone-cutters tell me, they can do nothing without it. It pays no duty either where dug up or retailed.

" The colour of the ſtone is either very light brown, or purpliſh, in the proportion of twenty to one of the latter; but in uſe no preference is given, and they are uſed equally. To an indifferent perſon the moſt ſtriking circumſtance is its great weight.

" As the ſpot I have been ſpeaking of now compoſes a part of the Company's territories, the moſt minute information on the ſubject may be acquired.

" I felt particular ſatisfaction at having been the firſt European who was ever at the place; and I ſhall be much gratified, if the account given meets with your approbation.

" I ſhall diſpatch a load of the ſtone in a day or two, which I got at the Pollam, with the charge of it. The diſtance from this place, by Namcul, is 84 miles.

" *The charges of 50lb. weight of Corundum.*

" Nine Tritchinopoly meaſures of the corundum ſtone weigh 50lb.

" Average and Coſt at the Pits *.	*P.*	*F.*	*C.*
" 1½ Madras farams per meaſure - - - - - -	0	13	40
Cooley, from thence to Tritchinopoly - - - -	0	28	40
Ditto from Tritchinopoly - - - - - - - - -	1	13	40
Pagodas	2	10	40

" The ſtone is delivered by meaſures, and paid for at the Pollam in the gold fanam.

" I am, &c.

"Nov. 15, 1792. " EDWARD GARROW."

This letter contains very intereſting topographical obſervations on the mine. The ſpecimens ſent were of one ſort of a greyiſh colour, with a ſhade of green. The entire cryſtals which I ſelected among the broken ones were, of courſe, few in proportion; but with the addition of ſome diſtinct cryſtals, which Col. Cathcart, and Capt. Colin Macauley had ſent me, have been ſufficient to aſcertain the ſtructure and form of the cryſtals, of which an analytical deſcription will cloſe this paper. I ſhall, therefore, now ſay nothing concerning their form, but proceed to give an account of the varieties of corundum ſtone, which I have obtained from India and China.

In the year 1786, Col. Cathcart ſent me a ſmall fragment of a ſtratified maſs from Bengal, with this label: " Corundum, much inferior in price to that of the coaſt." It is of a purpliſh hue; its fracture like compact ſand-ſtones; and a confuſed cryſtallization appears in all

* The above is the prime coſt. I have been informed by correſpondents who purchaſed ſome in retail, that it was ſold for about ſix ſhillings a pound at Madras.

parts

parts of the ſtone, by fibres of a white colour, from which the light is reflected as in feld-ſpar, &c.

I have ſince obtained a larger lump of the ſtone of the ſame texture, but rather paler in its purpliſh hue. Sir John Macgregor Murray informed me, that it is called by the natives of Bengal, *corone*, and uſed for poliſhing ſtones, and for all the purpoſes of emery.

Its ſpecific gravity is 3,876.

Capt. Colin Macauley procured a lump of corundum from a *ſikuldar* (a poliſher, this term is moſt appropriate to poliſhers of ſteel), in whoſe family it had been above twenty years, employed for grinding and poliſhing ſtones or gems. The uſe to which it had been ſo long devoted, had occaſioned grooves in its ſurfaces which facilitated greatly the examination of its ſtructure. It is about $5\frac{1}{2}$ inches long, $3\frac{1}{2}$ inches broad, and above two inches thick. On one of its broad ſurfaces are two oval grooves; one of them is four inches long, one broad, and $\frac{3}{4}$ of an inch deep. On the oppoſite ſide is a ſhorter oval groove, above $2\frac{1}{2}$ inches long, $1\frac{1}{2}$ inch broad, and one inch deep. In theſe grooves, the ends of the laminæ of the claſs reflect the light like the cryſtals. It ſerves as a ſpecimen of the ſimple apparatus of an Indian lapidary. Stones poliſhed in theſe grooves, would be of the common India poliſh, and form *en cabochon*, which is often called tallow-drop from the French lapidaries' term *goutte de ſuif*, convex, oval, or circular. A very ſmall quantity of the corundum powder would be required, as the action of the powdered corundum and gems on the lump of corundum would, as appears from the depth of the grooves, wear away from it a ſupply of powder for the operation of poliſhing. It appears to be part of a larger maſs, is of a purpliſh colour, and of the ſame laminated texture as the cryſtals of corundum; it has this peculiarity, there appear cracks branching irregularly acroſs the laminæ of the lump, which are filled with homogeneous matter, diſtinguiſhed, however, by the ſuperior purity, which might be expected to ariſe from the degree of filtration required for its depoſition in the fiſſures. Some of theſe cracks, which terminate on the ſurface, appear to have the ſame cryſtallized arrangement which characterizes the laminæ of corundum. The cracks not being, in any degree, influenced in their direction by the laminæ of the cryſtallized maſs, it is probable they had not been conſolidated when they cracked; and from this ſpecimen, we may expect to find corundum cementing maſſes of ſtone by the ſame proceſs of ſtalactitical cementation, by which quartz and calcedony connect great nodules and maſſes of ſiliceous ſtones.

In this ſpecimen, I conſider the veins as pure corundum, that is, having the ſame ſpecific gravity, hardneſs, and texture, as corundum cryſtals; and I found the whole lump poſſeſſed all the qualities of corundum, except its ſpecific gravity, which amounted only to 2,785; and, in this property, it correſponded nearly with the matrix of the corundum cryſtals, or the vein in which corundum is before ſtated to be found; the ſpecific gravity of which is 2,768. The texture of the matrix appears ſometimes like adularia, and confuſedly cryſtallized; often compact like cipoline or primitive marble; ſometimes ſparry, ſometimes granulated; and on the outſide of the vein, and near fiſſures, decompoſed and becoming opaque. In all its ſtates it ſcratches glaſs, but not rock-cryſtal, poſſibly from want of adherence of its particles:

particles: and in this, it differs from the ſubſtance of the above lump, which cuts glaſs and rock-cryſtal with great facility.

This lump, and the matrix of corundum, appeared to poſſeſs the ſame properties as corundum, when examined by the blow-pipe with the different fluxes.

The matrix of corundum having ſometimes an appearance like adularia and feldſpar, I aſcertained, by Mr. Hatchett's ſcales, the ſpecific gravity of adularia to be 2,558, and of feldſpar 2,555. The corundum, and the lighter corundum of the lump, cut adularia and feldſpar; the latter effervеſced, and combined with ſoda, which the former did not.

It is, therefore, evident that the matrix of corundum, or ſubſtance of the vein, is a diſtinct ſubſtance from adularia and feldſpar, and nearly connected with corundum.

The matrix, or vein, contains alſo a black ſubſtance like thorl, which, on cloſer examination, appears to be *hornblende*. This ſubſtance, Mr. Garrow had remarked to have the appearance of charcoal; and, on that account, he had attributed the formation of theſe ſtrata to the agency of fire. Other gentlemen, from the appearance of the matrix of corundum, have ſtated it to be a calcareous vein.

Mr. Garrow obſerved that there ran through the ſtrata, in which the corundum was found, veins of a ſubſtance like dried pitch, apparently on their edge, which ſeparated like a pack of cards. It is a brown micaceous ſubſtance, which, in drying, foliates, and ſhews a certain degree of regular arrangement of the component parts; in this caſe, the fragments of the folia ſubdivide with ſome degree of regularity into rhombs, whoſe angles are 60° and 120°: it is more ſmooth and leſs flexible than pure mica.

Theſe are all the ſorts of corundum which I procured from India.

I now proceed to the reſult of my inquiries in China.

I requeſted Capt. Cumming, in 1786, at that time commanding the company's ſhip, Britannia, to take a ſpecimen of corundum to China, to aſcertain its nature, and to obtain ſpecimens, if poſſible, adhering to their matrix, and regularly cryſtallized. On his arrival at Canton, he collected the information I wiſhed, with the good ſenſe and zealous deſire which he always exerts for his friends. He aſcertained that the ſtone I inquired for was in common uſe with the ſtone-cutters; and he brought me the ſtone in its rude and in its pounded ſtate, taking care to ſelect the moſt regularly cryſtallized pieces, and others adhering to the rock. A ſtone-cutter was ſawing rock-cryſtal with a hand-ſaw, which he alſo brought to me; it is a piece of bamboo ſlit, about three feet long, and $1\frac{3}{4}$ inch broad, thickened at the handle by a piece of wood, rivetted with two iron pins; having a lump of lead tied with a thong of ſplit rattan, ſteadying an iron pin, on which the end of a twiſted iron-wire is faſtened, which being ſtretched to the handle, is paſſed through a hole in the bamboo with the ſuperabundant wire; a wooden peg being preſſed into the hole, keeps the bow bent, and the wire ſtretched, and ſerves to coil the ſuperfluous wire, till, by ſawing the cryſtal, the ſtretched wire is worn, and requires to be renewed from the coil. The twiſted wire anſwers the purpoſe of a ſaw, and retains the powder of corundum and water, which are uſed in this operation. Dr. Lind had before brought ſpecimens ſimilar to the above from China.

From Sir Joſeph Banks, I obtained Dr. Lind's ſpecimens, and ſome in powder, which Mr. Duncan, ſupercargo, in China, had ſent him with the Chineſe name, pou-ſa. The matrix

trix being mixed with a red and white ſparry ſubſtance and mica, is generally called red granite; but it appears to me of the ſame nature as the matrix of corundum from India. The white is more fibrous, and like cyanite; the red part of it is compact and opaque; other parts appear to foliate, and pure mica is in conſiderable patches, and generally adheres to the cryſtals. This corundum is of a darker brown, and more irregular on the ſurface, than the corundum of the coaſt, and often mixed with black iron ore* attractable by the magnet.

It is deſcribed as the third modification of the corundum cryſtal in the analytical deſcription which follows. The *chatoyant*, or play of light, on theſe dark cryſtals, is very remarkable: ſome are of a bright copper colour; others exhibit the accident of reflection of light, which, in a poliſhed ſtate, gives varieties to the cat's-eye, ſtar-ſtone, ſun-ſtone, &c; which as yet are claſſed from ſuch accident without ſtrict attention to their nature, which is various, and, in general, has not been aſcertained.

Theſe are the circumſtances connected with the ſtrata, worth mentioning. The examination of corundum, on which our preſent knowledge reſts, is nearly that which an India mineralogiſt might derive of the hiſtory of feldſpar from a lump of Aberdeen granite out of one or two different quarries. He might aſcertain a few modifications of the cryſtal of feldſpar, its fracture, and matrix; but he would have no knowledge of the pureſt or more beautiful ſorts, which other quarries produce in Scotland, at Baverno, at St. Gothard, and Auvergne. I therefore think it eſſential to mention that corundum, under circumſtances favourable to its cryſtallization, becomes glaſſy in its fracture, and of various colours. I have not only obſerved in cryſtals of corundum ſpecks of a fine ruby colour, but I have fragments of cryſtals in texture and every reſpect like the colourleſs corundum, of a fine red colour. It is certain that we obtain from India, corundum which may paſs for rubies. I have ſent to India ſome of the corundum with ſmall ruby ſpecks, which were not ſufficiently diſtinct or large, either for meaſurement or analyſis, in hopes of being enabled to aſcertain correctly the form of *Salam* rubies found in corundum; in the mean time, I have the corundum of a fine red colour. Looking over ſome poliſhed rubies from India, I ſelected one which appeared laminated like corundum, and had alſo the *chatoyant*, or play of light, on its laminæ, which formed an angle in the ſtone. The lapidary called it an oriental ruby. I altered the form of the cutting ſo fortunately that the reflected rays formed a perfect ſtar; a phænomenon I had obſerved in the ſapphire, and expected in corundum, but not in the octoedral ruby. The ſpecific gravity of this ſtone being 4,166, confirmed my opinion that it is one of the *Salam* rubies, ſo much eſteemed by the natives on the coaſt or peninſula of India, which are found in the corundum vein. The ſpecific gravity of a colourleſs ſapphire very little leſs opaque than corundum, forming alſo a perfect ſtar, was 4,000; that of a deep blue ſapphire, and of a ſtar-ſtone, 4,035; all which I connect with the corundum; the ſpecific gravity of a

* A ſmall group, conſiſting of three or four octoedral cryſtals, preſents the leaſt common variety of this kind of iron ore; the edges of the octoedra being replaced by planes, which almoſt cover the triangular planes. *Romé de l'Iſle.* Criſtallog. vol. IV. plate 4, fig. 69.

diſtinct

distinct crystal of which was 3,950; of a fragment of ruby-coloured corundum, 3,959; and of a fragment of corundum with vitreous lustre, 3,954.

It may be objected to me, that Bergman has stated the variety of specific gravity in gems to be so great, as to leave no certain rule of judging thereby of the species. He observed, that the topaz generally prevails in weight, being from 3,460 to 4,560; the ruby from 3,180 to 4,240; then the sapphire from 3,650 to 3,940*. But, in the preceding page, he had said, "Analysi crystallorum tam ejusdem quam diversæ figuræ multum lucis scientia expectat. Illæ quarum antea compositionem explorare licuit naturali forma per artem privatæ erant." It is not, therefore, an hypothesis unworthy of examination which I advance, that gems, derived from the rectangled octoedra, whose specific gravity is above 3,300 to 3,800, will be found to be diamonds, or octoedral rubies; and these will be easily distinguished from each other by their lustre and hardness. Diamonds, whether red, yellow, blue, or white, being hardest, though their specific gravity will be less; viz. from 3,356 to 3,471, as I found among different diamonds in my collection: whereas the octoedral ruby was from 3,571 to 3,625, and inferior in hardness not only to the diamond, but to the corundum; the specific gravity of which, in its different appearance of form and colour, I found to vary from 3,876 to 4,166; and I suppose it to be subject to a variation from 3,300 to 4,300: after which the jargon will come with a specific gravity of 4,600; easily distinguished also by its crystallization from the above-mentioned gems. The above specific gravities Mr. Hatchett very obligingly assisted me in taking with his accurate scales, in the temperature of 60°. It will not be understood that I depend entirely on the specific gravity; on the contrary, I connect this quality with crystallization: hardness is the next criterion; and analysis must separate the component parts, and demonstrate the analogy, or identity, of substances, or of compounds. The improvements of Mr. Klaproth's process are evident by the comparison of his first analysis, and in his last analysis of corundum.

In the first it consisted of

Corundum earth - - - -	68 0
Siliceous earth - - - - -	31 50
Iron and nickel - - - - -	0 50
	100

By the last analysis of Mr. Klaproth, the corundum of the peninsula of India consisted of

Argillaceous earth - - - -	89 50
Siliceous earth - - - - -	5 50
Oxide of iron - - - - -	1 25
Loss - - - - - -	3 75
	100

* De Terrâ Gemmarum. Berg. Opusc. vol. II. p. 104.

The

The corundum of China,

Argillaceous earth - - - -	84 0
Siliceous earth - - - -	6 50
Oxide of iron - - - - -	7 50
Loſs - - - - - - -	2 0
	100

That the analyſis of ſapphire of Mr. Klaproth may be compared, it is here added.

Argillaceous earth - - - -	98 50
Calx of iron - - - - -	1 0
Calcareous earth - - - -	0 50
	100

Iron-ore cryſtallized is often mixed with the Chineſe corundum, as I have before ſtated, and may be conſidered as accidentally interpoſed, not combined. In the corundum of the coaſt, the greeniſh colour may indicate the combination of iron, as the blue colour does in the ſapphire; and the proportion of iron in both is nearly alike.

There, then, is the $\frac{5\ 50}{100}$ and $\frac{6\ 50}{100}$ of ſilex in corundum, evidently an integral part of the coarſe corundum cryſtal, and not of the ſapphire; but it will require an analyſis of the vitreous or pellucid corundum to decide that ſilex is a conſtituent part of corundum: there will then remain to account for the calcareous earth; and, having eſtabliſhed its being a conſtituent part of the ſapphire, the ſmall proportion of $\frac{0\ 5}{100}$ cannot be expected to produce a very notable difference.

It is not neceſſary to do more than thus to hint at what further analyſis and examination of former experiments are required, to aſcertain the analogy or identity of the ſapphire and oriental ruby with corundum.

I have before ſtated, that I have corundum (which has the ſame texture and fracture as the common colourleſs corundum) of a ruby red, and alſo of ſapphire blue, and of ſapphire blue and white colours.

I have ſapphires yellow and blue, white and blue, brown and greeniſh, and of a purpliſh hue; theſe I ſhould conſider as corundum, with fracture of vitreous luſtre.

(To be continued.)

II.

An Account of a ſingular Halo of the Moon. In a Letter from WILLIAM HALL, *Eſq. of Whitehall, F.R.S. Edin. to Sir* JAMES HALL, *Bart. F.R.S. Edin.**

Whitehall, near Berwick, April 2, 1796.

DEAR SIR JAMES,

I SEND, under cover, the repreſentation of a very ſingular halo of the moon (pl. XXII. fig. 25.) ſeen here on the night of the 18th of February laſt, about ten o'clock; and this I have

* Edinburgh Tranſactions, vol. IV. page 173.

have hitherto delayed, in order, if poſſible, to gain farther information in the neighbourhood concerning it.

During the ſhort continuance of the ſmall halo, which did not exceed ten minutes after I got notice of it, I could not lay my hands on any other inſtrument, to take the angles, but a Siſſon's theodolite, which unlucklily having been conſtructed ſo as not to admit of a vertical angle ſo great as the moon's altitude then was, I laid it aſide, not recollecting that it might have meaſured ſeveral of the ſmaller angles. But I obſerved ſundry marks, from which I took the angles as exactly as I could next day.

The moon was about ſouth-weſt, and her altitude nearly 54°, which, of conſequence, was alſo the higheſt altitude of the limb of the greater halo where it was higheſt, and where it paſſed through the moon; the altitude of its oppoſite limb was 14°; ſo that its diameter ſubtended an angle of no leſs than a hundred and twelve degrees.

The diameter of the ſmall halo, which appeared to be a perfect circle, with the moon in its centre, I found, after repeated trials, was under 12°, and more than 8°; but as the different diameters of the large halo were not meaſured, it cannot poſitively be affirmed, that it was an exact circle; on the contrary, its limb did not ſeem to interſect the ſmall circle quite ſo much at right angles as the circular arch delineated in the plan. It may, therefore, have been ſomewhat elliptical.

The ſmall circle was remarkably bright, particularly at Weſt Reſton, about five miles to the northward, the only other place where the halo was obſerved, and where it was thought to ſend forth flame. The ſmall halo alſo continued there much longer than here, where ſome thin fleecy clouds ſoon put an end to it; but the large halo continued with us near an hour.

The weather about this time was, for the ſeaſon, remarkably mild, particularly on the day of the halo. The ſky was pretty clear all that day, and alſo in the evening; but, at the time of the halo, there was a ſmall degree of hazineſs, particularly towards the north, which did not, however, prevent the moon from ſhining with brightneſs; and the ſtars were even viſible within the circle of the ſmall halo: there was little or no wind.

The circles, or belts, of both halos are repreſented in the plan nearly of their apparent breadth, or, perhaps, a little broader: the light of both was whitiſh, and conſiderably bright, without colour; that of the large circle was the paler of the two, particularly where it paſſed through the ſmall circle: to the northward it was ſomewhat obſcure.

By means of the angles taken as above, after having aſcertained, on a vertical circle of the heavens, the ſituations of the moon, of the ſmall halo, and of the north-eaſtern limb of the large halo, whoſe ſouth-weſtern limb paſſed through the moon, the whole was projected on the horizontal plane, as in the figure already referred to. The moon, a little more than half, is placed in the centre of the ſmaller halo; and both halos are repreſented in their true ſituations, relatively to the horizon, and in the circular ſhape which they appeared to have; though they ought, perhaps, to have been ſomewhat foreſhortened, and thrown into an elliptic form.

This halo, as you will ſee by the above deſcription, appears to be of the kind called by the learned a *corona;* and as it ſomewhat reſembles the famous one of the ſun obſerved at Rome

Rome in the year 1629, and described by Scheiner*, it deserves the more attention, especially as the great halo on the present occasion, having its south-western limb elevated to the height of 540°, and its north-eastern depressed to within 14° of the horizon, was in an oblique position, not easily reconciled with the theory of Huygens, which seems to require that such circles should be equally elevated above the horizon all round. It also shews that Scheiner's original plan of the halo at Rome, which represented it as oblique, may have been right, and that Huygens' correction, which makes it parallel to the horizon, was probably an erroneous conjecture.

I am,

dear Sir James,

your humble servant,

WILLIAM HALL.

III.

Experimental Researches concerning the Principle of the lateral Communication of Motion in Fluids, applied to the Explanation of various Hydraulic Phenomena. By Citizen J. B. VENTURI, Professor of Experimental Philosophy at Modena, Member of the Italian Society, of the Institute of Bologna, the Agrarian Society of Turin, &c.

(Continued from page 426, vol. II.)

EXPERIMENT XXIII. The two tubes A B C, D E F, fig. 14. Plate XXII. are 15 inches long; their diameter is 14,5 lines. The conical portions A, D, have the form of the contraction of the vein of fluid, and are applied to the orifice P, fig. 1. Plate VIII. of the present volume, which is 18 lines in diameter, with 32,5 inches depth, or charge of superincumbent fluid. The elbows, or flexures, B C, E F, are made in the plane of the horizon. These two pipes are made of copper soldered with silver, and the workmanship carefully executed. The curvature B C was drawn out, or bended, into the form of a quarter of a circle, by filling the tube with melted lead, in order that it might preserve its diameter during the act of bending. The elbow D E F is constructed in a right angle. The expenditure through these two tubes was compared with that afforded through a right-lined cylindrical tube of similar dimensions, and in like circumstances. The four cubical feet of water flowed out of the cylindrical tube in 45″; out of the curved tube A B C in 50″; and out of the angular tube D E F in 70″.

4. It is of importance that the tube B C, fig. 13. Plate VIII. should be of an equal diameter throughout. It is not enough that care be taken that there shall be no contraction, it is also necessary that it should not be enlarged at any part. For such enlargements have nearly the same bad effect in the expenditure as contractions. The pipe A O, fig. 12. affords a much less quantity of fluid with the dilatations D E, H I, than if it were of a diameter equal to that at B throughout its whole length. The following experiment agrees with the theory.

* Smith's Optics, vol. I. § 534.

Experiment

Experiment XXIV. The circular orifice A, fig. 12. has the form of the contraction of the vein, and the remaining part of the tube is interrupted by various enlargements of its diameter. This tube is applied to the aperture P, fig. 1. The dimensions of its parts measured in lines are as follows. Diameter at A = 11,2. Diameter at B, C, F, G, &c. = 9. Length of B C = F G, &c. = 20. Length of C D = E F = G H, &c. = 13. Diameter of the enlarged parts = 24. The length of each of the enlarged parts was variable. The first time of trial it was 38 lines, the second 76, and the result of the experiment was the same in both cases.

Number of enlarged parts.	Time during which four cubical feet issued out.
0	109″
1	147″
3	192″
5	240″

I afterwards applied to the same orifice a tube, having the same form, and the same diameter, as A B C, but cylindrical throughout, without any enlargements, and its length was 36 inches, the same as that of the tube with five enlarged parts; in this case the expenditure of four cubical feet was made in 148″.

When the fluid passes from C to the middle of the enlarged part D E, part of the motion is diverted from the direction C F towards the lateral parts of the enlargement. This part of the motion is consumed in eddies, or against the sides. Consequently there remains so much the less motion in the following branch F G. This is also the cause which destroys, or weakens, the pulse in the arteries beyond an aneurism.

From this consideration we are justified in concluding, that if the internal roughness of a pipe diminishes the expenditure, the friction of the water against these asperities does not form any considerable part of the cause. A right-lined tube may have its internal surface highly polished. Throughout its whole length, it may every where possess a diameter greater than the orifice to which it is applied; but, nevertheless, the expenditure will be greatly retarded if the pipe should have enlarged parts, or swellings. This is a very interesting circumstance, to which, perhaps, sufficient attention has not been paid in the construction of hydraulic machines. It is not enough that elbows and contractions are avoided; for it may happen, by an intermediate enlargement, that the whole advantage may be lost, which may have been procured by the ingenious dispositions of the other parts of the machine.

PROPOSITION VIII.

In the machine for blowing by means of a fall of water, the air is afforded to the furnace by the accelerating force of gravity and the lateral communication of motion, combined together.

The Academy of Toulouse, in the year 1791, invited philosophers to determine the cause and the nature of the stream of air which is produced by the fall of water in certain forges. I propose, in this place, to develope the complete action of this kind of blowing apparatus, and to ascertain the best form of construction. Kircher is the first I know of who has explained

plained the production of wind by a fall of water *. Barthes, the father, has given a theory which appears to me to be defective in many respects †. Dietrich was of opinion, that this wind is produced by the decomposition of water ‡. Fabri had a similar notion in the last century §. Most philosophers are well acquainted with this kind of engine ‖.

I shall begin with an idea, the foundation of which did not escape the penetration of Leonardo Da Vinci. Suppose a number of equal balls to move in contact with each other along the horizontal line A B, fig. 16. Plate XXII. Imagine them to pass with an uniform motion, at the rate of four balls in a second. Let us take B F, equal to 16 feet English. During each second four balls will fall from B to F, and their respective distances in falling will be nearly B C = 1, C D = 3, D E = 5, E F = 7. We have here a very evident representation of the separation, and successive elongation, which the accelerating force of gravity produces between bodies which fall after each other.

The rain water flows out of gutters by a continued current; but during its fall it separates into portions in the vertical direction, and strikes the pavement with distinct blows. The water likewise divides, and is scattered in the horizontal direction. The stream which issues out of the gutter may be one inch in diameter, and strike the pavement over the space of one foot. The air which exists between the vertical and horizontal separations of the water which falls, is impelled and carried downwards. Other air succeeds laterally; and in this manner a current of air, or wind, is produced round the place struck by the water. I went to the foot of the cascades which fall from the Glacière of La Roche Mêlon, on the naked rock at La Novalêse, towards Mount Cenis, and found the force of the wind to be such as could scarcely be withstood. If the cascade falls into a bason the air is carried to the bottom, whence it rises with violence, and disperses the water all round in the form of a mist.

The water which is precipitated in the hollow internal parts of mountains carries the air with it, which afterwards issuing forth from apertures at the foot of the mountain, produces those natural blasts, those *ventaroli* ¶, which are most frequently observed in the volcanic mountains, because these mountains are most commonly hollow within.

Let B C D E, fig. 16. represent a pipe, through which the water of a canal A B falls into the lower receiver, M N. The sides of the tube have openings all round, through which the air freely enters to supply what the water carries down in its fall. This mixture of water and air proceeds to strike a mass of stone Q; whence rebounding through the whole width of the receiver M N, the water separates from the air, and falls to the bottom at X Z, whence it is discharged into the lower channel or drain, by one or more openings, T, V. The

* Mundus Subterr. lib. XIV. cap. 5, edit. 1662.

† Mémoires des Savans étrangers, vol. III. p. 378.

‡ Gites de Minerai des Pyrénées, p. 48, 49.

§ Physic. tract I. lib. II. prop. 243.

‖ Art des Forges, part II. Mariotte des Eaux, part I. disc. III. Transact. No. 473, &c.

¶ These *ventaroli* are sometimes produced by the difference of temperature between the air of the cavern and the external air.—V. From the effects they seem to be oftener produced by this last cause, than by a fall of water. On this subject in general, namely, the cold winds which issue out of the earth, see Philos. Journal, I. 229.—N.

air

air being lefs heavy than the water, occupies the upper part of the receiver, whence being urged through the upper pipe O, it is conveyed to the forge.

Experiment 25. I formed one of thefe artificial blowing engines of a fmall fize. The pipe B D was two inches in diameter, and four feet in height. When the water accurately filled the fection B C, and all the lateral openings of the pipe B D E C were clofed, the pipe O no longer offered any wind.

It is, therefore, evident that in the open pipes the whole of the wind comes from the atmofphere, and no portion is afforded by the decompofition of water. Water cannot be decompofed, and transformed into gas, by the fimple agitation and mechanical percuffion of its parts. The opinion of Fabri and Dietrich have no foundation in nature, and are contrary to experiment.

It remains, therefore, to determine the circumftances proper to drive into the receiver, M N, the greateft quantity of air, and to meafure that quantity. The circumftances which favour the moft abundant production of wind, are the following.

It is known that in the parabola, if $d x$ be affumed as conftant, $d y$ will decreafe in the ratio of $\frac{1}{\sqrt{x}}$. The feparation of the balls in fig. 15. is more rapid in the upper fpaces of the fall than in the lower. In order, therefore, to obtain the greateft effect from the acceleration of gravity, it is neceffary that the water fhould begin to fall at B C, fig. 16. with the leaft poffible velocity; and that the height of the water F B fhould be no more than is neceffary to fill the fection B C. I fuppofe the vertical velocity of this fection to be produced by an height or head equal to B C.

2. We do not yet know, by direct experiment, the diftance to which the lateral communication of motion between water and air can extend itfelf; but we may admit with confidence, that it can take place in a fection double that of the original fection, with which the water enters the pipe. Let us fuppofe the fection of the pipe B D E C to be double the fection of the water at B C; and in order that the ftream of fluid may extend and divide itfelf through the whole double fection of the pipe, fome bars, or a grate, are placed in B C, to diftribute and fcatter the water through the whole internal part of the pipe.

3. Since the air is required to move in the pipe O with a certain velocity, it muft be compreffed in the receiver. This compreffion will be proportioned to the fum of the accelerations, which fhall have been deftroyed in the inferior part K D of the pipe. Taking K D $=1,5$ feet, we fhall have a preffure fufficient to give the requifite velocity in the pipe O. The fides of the portion K D, as well as thofe of the receiver M N, muft be exactly clofed in every part.

4. The lateral openings in the remaining part of the pipe B K, may be fo difpofed and multiplied, particularly at the upper part, that the air may have free accefs within the tube. I will fuppofe them to be fuch that 0,1 foot height of water might be fufficient to give the neceffary velocity to the air at its introduction through the apertures.

All thefe conditions being attended to, and fuppofing the pipe B D to be cylindrical, it is required to determine the quantity of air which paffes in a given time through the circular fection K L. Let us take in feet K B $=1,5$; B C $=$ B F $=a$; B D $=b$. By the common theory of falling bodies, the velocity in K L will be $7,76\sqrt{(a+b-1,4)}$; the circular fection K L $=0,785a^2$. Admitting that the air in K L to have acquired the fame velocity as the

the water, the quantity of the mixture of the water and air which paffes in a fecond through K L is $= 6,1\ a^2 \surd\ (a+b-1,4)$. We muft deduct from the quantity $(a+b-1,4)$ that height which anfwers to the velocity the water muft lofe by that portion of velocity which it communicates to the air laterally introduced; but this quantity is fo fmall that it may be neglected in the calculation. The water which paffes in the fame time of one fecond through B C is $= 0,4\ a^2 \surd\ (a+0,1)$. Confequently, the quantity of air which paffes in one fecond through K L, will be $= 6,1\ a^2 \surd\ (a+b-1,4) - 0,4\ a^2 \surd\ (a+0,1)$, taking the air itfelf, even in its ordinary ftate of compreffion, under the weight of the atmofphere. It will be proper, in practical applications, to deduct one-fourth from this quantity; 1, on account of the fhocks which the fcattered water fuftains againft the inferior part of the tube, which deprive it of part of its motion; and, 2, becaufe it muft happen that the air in L K will not, in all its parts, have acquired the fame velocity as the water.

If the pipe O do not difcharge the whole quantity of air afforded by the fall, the water will defcend at X Z; the point K will rife in the pipe, the afflux of air will diminifh, and part of the wind will iffue out of the lower lateral apertures of the pipe B K.

I fhall not here examine the greater or lefs degree of perfection of the different forms of water-blowing machines, which are ufed at various iron forges, fuch as thofe of the Catalans, and elfewhere. Thefe points may be eafily determined from the principles here laid down.

PROPOSITION IX.

It is poffible, by means of a fall of water, to drain a piece of ground, without the help of machines; even though the ground fhould lie on a lower level, than the eftablifhed current, below the fall.

The means of doing this is pointed out in the firft experiment of this treatife. We have feen that the water contained in the veffel D E F B, fig. 3. Plate VIII. iffues through the channel M B V, which is higher than the furface of the water itfelf, becaufe the fluid which paffes through A C carries with it the water contained in the veffel.

In the artificial fall, which is procured in channels to give motion to mills, when the water rufhes down by a rectangular trunk of wood, D B C F, fig. 17. placed nearly horizontal in the middle of the lower channel, the furface of the water at K is one or two feet beneath the inferior current (or back-water) F L*. The water at F tends to return and defcend along F K; but the current, by its lateral action, conftantly carries it away, and does not permit it to flide down to K. If an opening G be made in the lateral fides of the trunk, the waters from lands lower than the current of the inferior ftream F L may be drained off. In a commiffion with feveral of my colleagues, I once propofed, that this principle fhould be applied to a cafe of practice. The project was adopted, and the drainage fucceeded very well.

The rectangular conduit D D F C muft be prolonged to a certain extent along the lower channel, otherwife the water might flow back from F to K, and oppofe the drainage through G. The mill-wrights are aware of the utility of this prolongation. Experiment has taught

* This depreffion of the level has already been noticed in K. Guilielmi, della natura dè fiumi, cap. 7, fig. 46. Boffut, art. 721. The wheel alluded to in the text muft, I prefume, be of that kind which we call a breaft-wheel.—N.

them

them, that it prevents the water from returning back ſo readily in the time of floods, which might check the motion of the water-wheel. For this purpoſe, they make the upper part D F at the height of the waters, which the mill-ſtream can reſiſt or ſupport. The town of Final, in the territory of Modena, having charged me with the direction of changing the courſe of part of the waters of the Panaro, which the circumſtances of the town required to be done; I availed myſelf of this prolongation of the tail-pipe D F, combined with other artifices, to maintain the action of mills in the new channel; and I ſucceeded not only beyond the expectation of the inhabitants, but even beyond my own hopes.

PROPOSITION X.

The eddies of the water in rivers are produced by motion, communicated from the more rapid parts of the ſtream to the lateral parts, which are more at reſt.

Few authors have examined the cauſe and the effects of the eddies of water in rivers; and thoſe who have undertaken this inveſtigation, do not appear to have been very happy in their reſearches.

The water which moves in the channel M N H, fig. 19. meets the obſtacle B A, which impedes its courſe, and cauſes it to riſe and diſcharge itſelf in the direction A C with an increaſed velocity. Suppoſe the water in B D C A to be dormant, the current A C communicates its motion to the lateral particles E (Prop. I.), and conveys them forward; the ſurface of the dormant water becomes depreſſed at E, and the moſt remote particles towards D are urged according to the laws of the equilibrium of fluids to fill the depreſſion. The current A C continues to carry them off, and the ſpace B D C A continues to be exhauſted. The water of the current A C, by virtue of the ſame laws, is acted upon by a conſtant force which urges it towards the cavity E, while its natural courſe or projection carries it towards A C. Under the agency of theſe two forces, the water A C acquires a curve-lined motion in C D, and deſcends as it were through an inclined plane, becoming retrograde in D E, whence it would proceed to ſtrike the obſtacle B A, and the current A C, after which, it would undergo ſeveral oſcillations previous to acquiring a ſtate of equilibrium and repoſe. But the current A C continues its lateral action: a ſecond time it draws away the water through C D into E, and forces it to renew its motion through the curve C D E; in which manner the eddy continues without ceaſing.

If the river ſhould paſs through a contraction of its bed at N, it will produce eddies on both ſides, at P and at Q, ſimilar to thoſe we have contemplated at D C.

Suppoſe the ſtream of water, after having ſtruck the bank G H, to be reflected into a new direction H S, the lateral communication of motion will excite eddies in the angle of reflection R.

When two currents of unequal velocity meet obliquely in the middle of the river, the moſt rapid current will produce eddies in that which is the leaſt rapid.

Suppoſe a ſtream of water to flow over a bed of unequal depth. If the longitudinal ſection of the inequalities of the bottom exhibit a gentle ſlope, as at A B C, fig. 20. the ſuperior water will impreſs its motion by lateral communication upon the inferior water, which is near the bottom, beneath the line A C, and a current will take place through the whole depth of the

the section M B. The current which is formed near the bottom at B, is turned out of its course by the slope B C, and proceeds to rise above the surface at Q; sometimes in the form of a curling wave or vertical whirlpool. If the extremities of the hollow place form an abrupt angle, as D E, F G, eddies will be produced even at the bottom, in the vertical direction at D, and sometimes also at G. These phenomena may be observed in an artificial channel with glass sides.

Every eddy destroys a part of the moving force of the current of the river. For the water which descends by a retrograde motion, in the inclined plane C D E, fig. 19. cannot be restored in the direction of the current of the river but by a new impulse. It is as it were a ball, which is forced to rise on an inclined plane, whence it continually falls back again to receive new impulsions. It is the labour of Sisyphus.

Hence I deduce, as a primary consequence, *that in a river, of which the course is permanent, and the sections of its bed unequal, the water continues more elevated than it would have done, if the whole river had been equally contracted to the dimensions of its smallest section.* The cause of this phenomenon is the same as that which retards the expenditure through the tube with enlarged parts. (Prop. VII. No. 4.) The water which descends from the elevation above the contracted part N, into the bason P Q, fig. 19. loses nearly the whole of the velocity it acquired by descending from it; because the narrow part has a curved slope towards the lower part of the river, which directs the velocity of the stream in an horizontal direction. Guilielmini has well remarked, that a fall does not influence the velocity of the lower stream, because the eddies of the water in the bason P Q destroy the velocity produced by the fall. This velocity increases the depth, and enlarges the width of the channel at P Q. Eddies are formed on each side, at the bottom, and at the surface; both in the horizontal and vertical directions. It would be to no purpose to atttempt to prevent this hollowing out and enlargement of the channel by such a fall, by adopting the means of close walls; for the bason would then obtain its enlargement, where these constructions might end.

If the channel have a number of successive contractions and dilations, M N, without cascade or dam, there will still be formed, at each dilatation, eddies which will diminish the velocity more than if the channel had an uniform section equal to that in M or N. It will, therefore, follow, that the surface of the water, after each dilatation, must rise, in order to recover the velocity it lost by the eddies. If we call the height to which the water must rise, above the elevation necessary to have overcome the retardations of a bed of uniform section, $= a$, and that the number of equal and successive alternate dilatations and contractions be $= m$, the height of the rise in the stream thus alternately dilated beyond that of the same river uniformly contracted will be $= am$. I here suppose the bottom of the river to be uniform. If this bottom be of such a nature to be attacked by the current, the contracted parts will be hollowed out, and the matter will be deposited in the enlarged parts.

The second consequence which I draw from the principle here established, respecting the loss of force, caused by the eddies, is of considerable importance in the theory of rivers, and appears to have been neglected by those who have treated on this subject. The friction of the water along the wet banks, and over the bottom of rivers, is very far from being the only cause of the retardation of their course, which, consequently, requires a continued descent to maintain

maintain its velocity. One of the principal, and moſt frequent, cauſes of retardation in a river, is alſo produced by the eddies, which are inceſſantly formed in the dilatations of the bed, the cavities of the bottom, the inequalities of the banks, the flexures or windings of its courſe, the currents which croſs each other, and the ſtreams which ſtrike each other with different velocities. A conſiderable part of the force of the current is thus employed to reſtore an equilibrium of motion, which that current itſelf does continually derange.

(To be continued.)

No. IV.

Concerning a new Variety of argillaceous Iron-ore. By SAMUEL L. MITCHILL, *M.D. of New York.*

SIR,

THE annexed deſcription of a mineral ſubſtance, and the remarks upon it, are taken, by permiſſion, from Dr. Mitchill's manuſcripts. As the ſubject appears to me worthy to be made known to the mineralogiſts of Europe, I have forwarded you a copy for publication, in your uſeful and inſtructive Journal; I have the ſatisfaction to inform you at the ſame time, that Mr. Bruce, a young gentleman who goes paſſenger to London in the ſame ſhip which conveys this note, is in poſſeſſion of a ſpecimen of this remarkable foſſil.

I am, Sir,

Your very obedient ſervant,

New-York, November 17, 1798. ADOLPH. C. LENT, M.D.

To Mr. W. Nicholſon.

A new Variety of Iron-ore of the argillaceous Kind, and figured ſomewhat like Baſaltes.

The ſpecimen of columnar iron-ore in my collection is from Germany, and correſponds very well with Mr. Kirwan's ſecond variety of his firſt family of argillaceous iron-ores. (2. Elements of Mineralogy, Dublin, 1796.) I knew of no other iron-ore of that character, until a few months ago. As I was walking on my farm upon Long-iſland, ſurveying the various mineral productions that lay thick under my feet, I obſerved a ſmall ſpot, that appeared to be paved, with ſtones of a regular figure; on taking up ſome of them and examining them, they were evidently of the ſame conſtitution with the common argillaceous iron-ſtone, which lay ſcattered about in rude lumps. They were, however, of a ſingular ſhape. They were about four inches long; and ſtood erect, ſide by ſide of each other, in a ſtiff loam. Each of them had five ſides and five angles; and though not exact pentagons, were readily diſtinguiſhable in moſt of the ſpecimens from one end to the other. This ſhape was moſt perfect at the two ends, which were conſiderably larger than the middle part, and about one inch and a half acroſs. So that when a ſpecimen of this ore was graſped in the hand, it had ſome reſemblance of a double-headed peſtle. In ſome, however, four ſides only were to be traced.

The

The number of these figured bodies was about thirty-six, though not all of them equally perfect. And they evidently had been formed from a solid circular mass of argillaceous iron-ore, of about two feet and five inches in breadth, and four inches in thickness, at the central parts, and becoming thinner towards the edges. In the natural fracture of the stone, the fragments took upon themselves these regular forms, very much resembling basaltes; and, like basaltes, though *figured* they evidently are not *crystallized*, for they are as perfectly terrigenous and opaque as any argillaceous ore of iron whatsoever.

I brought away some of the pentagonal pieces, and could easily get more of them, for in taking out the few that I brought away, I disturbed the rest as little as possible.

Do not these specimens go very far towards deciding the dispute, if any doubts still remain, about the *igneous* or *aqueous* origin of basaltes? they support, by the most powerful evidence, the *Neptunian* origin of that kind of figured bodies, and are directly opposed to the *Plutonic* system. The specimens before me prove, that argillaceous iron-ore, which nobody has supposed to be a volcanic production, can take on a basaltic figure. With Bergman, Weideman, and Kirwan, I am inclined to believe the weight of testimony is opposed to the formation of basaltic columns by fusion, and that the true manner, in which many, if not all, of them have been produced, is in the moist way. This new proof, added to Mr. Kirwan's very able paper on *traps* and *basaltes*, I think settles the controversy in his favour.

V.

Concerning the Invention of the Electrical Doubler. By Mr. John Read.

To Mr. NICHOLSON.

SIR,

In your journal, Nov. 1798, page 368, you charge me with want of candour, in my description of what I call the spectacle doubler of electricity. Whether this charge be just, or not, must be left to the decision of a judicious public: who, it is hoped, will have candour enough to compare your account of the doubler with mine. I was of opinion, that after giving you the priority of invention, which I have expressly done in page 29 of my work, entitled Summary View of the spontaneous Electricity of the Earth and Atmosphere, no further acknowledgement could be required. The passage is, "and to give the plates a considerably more extended insulation than that made by Mr. Nicholson, without augmenting the size of the instrument, &c."

That your charge is frivolous, will more fully appear from the following circumstance, namely, that Dr. Priestley did actually deliver my original manuscript into your hands, with full power to correct, erase, or add whatever you chose, and after you had retained it more than three months in your possession, I received the manuscript from you, and found that you had made no alteration at all in it: of course it went to the press in the dress it is now in.

It is not my intention, at present, to criticise on all you have said in the passage alluded to. As to the adopting some of your own words into my description, of nearly the same instrument, could not well be avoided; nor can it be thought an illiberal proceeding. But if you disliked it—

it—if you thought it improper, you ought to have mentioned it at a proper time, viz. when you returned the manuſcript, or before it was ſent to the preſs; and your requeſt would have been literally complied with. With regard to the inſtrument itſelf, it is at preſent uſeleſs; and it is allowed by all, that it has totally failed for want of a perfect inſulation. If this defect ſhould at ſome future time be overcome, the doubler of electricity, will *then* be the moſt *uſeful* and the moſt *noble* inſtrument in the whole group of electric apparatus.

I remain, ſir,

Your very humble ſervant,

JOHN READ.

Quadrant, in Knightſbridge,
January 17th, 1799.

Though the above letter relates to perſonal incidents, which may not, perhaps, be conſidered with any great degree of intereſt, yet I conceive my readers will admit the propriety of publiſhing it, in order that Mr. Read, whoſe candour, as an author, has been called in queſtion, may juſtify himſelf to that public, which he has eſſentially ſerved during a long life, employed as an inſtrument-maker and operative philoſopher. I am well content, that the deciſion reſpecting the doubler, ſhould be made by the tribunal to which he refers, and to which it of right belongs. If a careful review of what I have written, together with his preſent communication, had led me to alter my ſentiments, it would be my duty to ſay ſo in this place. But I think I have faithfully ſtated the facts in the paſſage he alludes to, and have only to remark, that the indirect mention of my name, in page 29 of his work, was little, if at all, calculated to deſtroy the concluſion which his readers would obviouſly be induced to make, from the unacknowledged copy in the former part of the chapter; in proof of which, the inference of the foreign philoſophers, who were miſled in his favour as the inventor, is nearly deciſive. His narrative reſpecting my having poſſeſſed his manuſcript, previous to its publication, is not quite correct in the manner, becauſe it does not communicate the whole of what happened. Either Dr. Prieſtley, or elſe Mr. Read with the Doctor's recommendation, did deliver to me certain manuſcripts about ſix or ſeven years ago, which I believe to have been part, or the whole, of what was ſince publiſhed, under the title of *A Summary View, &c.* but they were not put into my hands with the notion that any relation might ſubſiſt between me and their contents, which could require the full powers Mr. Read mentions;—but ſimply to correct and prepare them for the preſs, on condition of being paid for my labour. As I have always declined this kind of employ, excepting when motives of perſonal acquaintance or friendſhip have led me to it, I returned this copy untouched, and unperuſed, to the author, and ſuppoſed of courſe, that he had employed ſome other perſon to reviſe it. I hope and believe, therefore, that notwithſtanding this incident, upon which Mr. Read ſeems to place ſo much reliance, it cannot be thought to afford any ground for an inſinuation, that I have been induced to ſpeak as I have done, of his ſhare in the invention of the doubler, from any motives, but ſuch as ought to guide an independent narrator of philoſophical facts.

With

With regard to the inftrument itfelf, which is fo truly honourable to the fagacity of Lichtenberg, Klincock, Volta, and Bennett, but in which my fhare is certainly very trifling, I do not know that its imperfections are greater than was long fince afcertained by the Englifh electricians; of which an account is given in a paper, at page 394 of the firft volume of this Journal. If Mr. Read is in poffeffion of any new facts refpecting its operation, the public will, no doubt, receive them with as much attention and refpect, as they have paid to the refults of his former purfuits.

VI.

Inquiries refpecting the Conftruction of a Water-wheel, and the Manufacture of Bricks. By a Correfpondent.

Mr. Nicholfon will oblige a friend to his ufeful Journal, by giving, therein, information on the under points.

December, 1798.

ON a ftream where the fall is $6\frac{1}{2}$ feet, what diameter ought the water-wheel to be?

Whether a bucket-wheel, or float-board-wheel?

If the former, ought the water to be brought in at the height of the fall; or a portion given for head? and what portion?

Is there any practical direction in print, to direct the procefs of brick-making?

If there is not, Mr. N. would do a material fervice to numbers, who are in fome parts of the country, remote from the workmen who are fkilled in this art, by collecting and publifhing fuch practical directions of the nature of the materials and the procefs, as will enable the uninformed to fupply themfelves with this ufeful article.

The data, refpecting the above-mentioned ftream, are not fufficiently precife to determine whether a bucket-wheel, or float-board-wheel, would be preferable: the quantity of water afforded per minute ought to have been mentioned. The bucket-wheel appears, upon the whole, to be beft adapted to fmall ftreams of water with a confiderable fall; but, in contrary circumftances, the clofe breaft-wheel appears to be preferable, that is to fay, a wheel with float-boards, moving in a channel fo well fitted, as to permit the leaft poffible quantity of water to efcape, without acting upon the wheel.

The diameter of the wheel may, in theory, admit of confiderable variation. Admitting it to be a breaft-wheel, its radius muft be fomewhat more than the height of the fall. The velocity of the furface of fuch wheels, as are driven by the gravitating power of water, lies between two feet and fix feet per fecond. Three feet may be confidered as a good practical velocity, as determined by experience. It is of no advantage, but, on the contrary, a lofs, to confume any part of the head, in throwing the water againft the floats with a confiderable impulfe; it is only neceffary that the ftream fhould be delivered upon the wheel with fome-

what

what more velocity than that of the wheel itſelf. If the ſtream can be brought on with the velocity of three feet at the top of the fall, it will, undoubtedly, be beſt; but if the water ſhould flow from a pond, having no perceptible current, the portion or ſpace required to produce this velocity will be about one foot and a half.

Theſe remarks are equally applicable to bucket or overſhot wheels.

The art of brick-making is conciſely deſcribed in the French Encyclopedie. Bergmann has attended to this ſubject in a direct chemical way. A tranſlation of his treatiſe into Engliſh, may be ſeen in the third volume of his Phyſical and Chemical Eſſays; or an abridgement of the ſame in my Chemical Dictionary, article Brick. As the art itſelf is of extenſive utility, and of conſiderable ſimplicity in the practice, I ſhould, in this place, have deſcribed the proceſs, with remarks, if I were not deſirous of again inſpecting the methods which are practiſed in the neighbourhood of this metropolis. When I ſhall have done this, the account he deſires will appear.

VII.

On the Combuſtion of Phoſphorous.

To Mr. NICHOLSON.

SIR,

UPON putting a ſmall piece of phoſphorus in a ſhovel over the fire, in ſome experiments I lately made for the entertainment of a company of friends, that ſubſtance ſmoked, began to melt, and took fire as uſual. When the combuſtion had ceaſed, and we were looking at the ruddy coloured reſidue, or acid, one of the company wetted the reſidue by ſpitting upon it; at which inſtant, the combuſtion was renewed, with a crackling noiſe, at every part where the moiſture had reached. I ſuppoſe the reſidue to have been oxygenated phoſphorus, or phoſphoric acid; and that the addition conſiſted chiefly of hydrogen and oxygen. What then was the new combination, which was attended with the farther extrication of heat? Will you have the goodneſs to explain this fact, or ſubmit it to your correſpondents.

I am, Sir,

Your obliged reader,

January 4, 1799.

R. S.

I have complied with the requeſt of this correſpondent, by publiſhing his letter; upon which my other friends will make their remarks, if the ſubject ſhould appear to require it. If phoſphoric acid, at an elevated temperature, in contact with iron, can be made to emit heat and light by the addition of water, as R. S. apprehends, the true explanation of the play of affinity muſt be ſought from varied experiments, in which all the products, as well gaſeous as fixed, ſhould undergo examination. But in the inſtance before us, I am much inclined to think the renewed combuſtion is produced by a portion of phoſphorus, which eſcaped the atmoſpheric action in the firſt burning. That is to ſay, when a piece of phoſphorus is burned,

burned, in the circumstances of the present experiment, the upper or greatest part of the mass becomes acidified, and covers a portion beneath, so as to prevent that lower part from combining with the atmospheric oxygen; in consequence of which, the combustion ceases before the whole is burned. But when this dense acid becomes diluted with water, it boils, and most probably rises, at least so far as to leave the surface of the phosphorus below uncovered, and to permit the combustion to be renewed. Instances of volatility being given to various substances by water, are sufficiently numerous in chemistry; of which the acid of borax is one of the most striking. To what degree, the same effect may take place in the phosphoric, I am not aware. Scheele (on Air and Fire, §. 73), indeed, affirms, that water gives it fixity; but he says this in so loose a way, that I am not disposed to rely on the assertion, as universally true, in contradiction to some other facts, which shew that the diluted acid does partly rise by heat.

VIII.

Pyrometrical Essays to determine the Point to which Charcoal is a Non-conductor of Heat. By Citizen GUYTON *.

SINCE the experiments and researches of philosophers have been directed to the matter of heat, the state in which it is found, and the various manners in which it affects bodies, it has been well ascertained that charcoal is one of the worst conductors of heat. From this observation it has been proposed to form a double wall to furnaces, and to fill the intermediate space with charcoal; and, very recently, an happy application of this property has been made in the construction of vessels designed for the preserving the temperature of warm infusions.

I am not, however, acquainted with any researches which may have been made to fix, even comparatively, the limits of this kind of insulation. The effect of the non-conducting power of charcoal has been so slightly considered, even by the most accomplished chemists, that they have not thought it necessary to take any account of this effect in the result of their operations. Hence it is, that the celebrated Klaproth, in a series of experiments upon the alteration which stones undergo when exposed to extreme heat, seems to think that the heat might have been nearly equal in such as were contained in crucibles of porcelain, and those which were entirely surrounded with charcoal. The reduction of the oxides of tungsten, titanium, and uranium, has also been attempted in crucibles of charcoal, though it is well known that the highest degree of heat is here required for the fusion, and that, in other respects, every endeavour must be made to expose them to the most intense ignition.

These reflections have led me to conclude, that it might be of some importance to obtain a more accurate measure of this insulating effect of charcoal. The following are the experiments which I have made upon this subject.

Out of the same parcel I took two pyrometic pieces perfectly alike, and placed one, which I shall call A, in a crucible filled with pure siliceous sand dried over the fire. The crucible

* Read to the French National Institute, 6th Germinal, in the 6th year of the Republic (March 26, 1798); and inserted in the Annales de Chimie, XXVI. 225.

was

was 8 decemeters high, 6 in diameter at the mouth: the cylinder of clay was placed in the middle, and the crucible had its cover luted on.

The other piece, B, was placed in a ſimilar crucible, with this difference, that the crucible was filled with powder of charcoal, which had been previouſly ignited in a cloſe crucible.

The two crucibles were then placed beſide each other on the grate of a large melting furnace, in which the fire was kept up for about three quarters of an hour.

When the crucibles were cooled, the cylinder A was taken out of the ſand, and preſented to the pyrometic ſcale of Wedgewood; it had undergone a contraction of 89 degrees. The cylinder B was then taken out of the charcoal, and ſtopped in the gage at 60,25 degrees. It had acquired a grey tinge, but without any appearance of glazing.

Hence it follows, that the tranſmiſſion of heat through the ſand, is to the tranſmiſſion through the charcoal nearly in the proportion of 3 to 2. In proportion as this difference is in itſelf ſtriking, the more it becomes neceſſary to attend to ſuch precautions as are required to prevent deception ariſing from foreign circumſtances. The crucibles had moſt aſſuredly undergone the ſame degree of fire. The ſtate in which they were found exhibited the traces of its action: the conditions were therefore as equal as poſſible; but it might, poſſibly, be ſuſpected that ſome defect, or want of uniformity in the pyrometic piece, or ſome imperfection in its compoſition, or fabrication, might have altered its diſpoſition to contract equally, and proportionally to the heat it might undergo. There was a very ſimple method of removing theſe doubts; namely, to aſcertain whether the ſame piece put into the ſand, and expoſed to a much ſtronger heat, would reſume the common courſe of contraction, and agree with the former. This, in fact, was performed; the ſame two pieces, A and B, were incloſed in one and the ſame crucible filled with ſand, ſo that they were not more diſtant from each other than about 7 or 8 millimetres, and the crucible was expoſed for half an hour to the moſt violent heat of a forge, urged by three twyers.

The crucible, when cold, was found to have loſt ſome of its thickneſs by vitrification, ſo that there was a crack in one of its ſides. The ſand, however, was not deranged within.

The piece A marked 163,5 upon the pyrometic ſcale, it weighed no more than 1,491 grammes; its ſpecific gravity was 2,232.

The piece B exhibited 160 degrees on the pyrometer, it weighed 1,53 grammes, and its ſpecific gravity was 2,346. It had almoſt loſt the grey tinge which it had acquired in the charcoal, and was no longer diſtinguiſhable from the other but by a black vitreous point, produced by the acceſſion of ſome foreign matter.

I confeſs I did not expect to be ſo completely ſucceſsful in this verification: the ſmall difference of 3½ degrees is nothing, when we conſider that the piece firſt incloſed in the charcoal, and which had ſtopped at 60, was ſtill capable of contracting through an additional 100 degrees. It is, beſides, known to be phyſically impoſſible, that two bodies placed in the ſame crucible, and in contact with the ſame ſubſtance, ſhould be ſtrictly in the ſame ſituation as to the reception of heat, particularly when the blaſt is directed from three different nozzles, which are neceſſarily unequal. The advanced ſtate of one of the ſides of the crucible, with reſpect to the fuſion, is a proof that this was in fact the caſe.

We may therefore conclude from theſe eſſays, that the body included in the charcoal in the

the ſame fire, does not receive more than about two-thirds of the heat of a body ſurrounded with quartzoſe ſand; that the reduction of metals which do not flow at a lower degree of heat than 130 degrees, cannot be effected in charcoal; that the pyrometric pieces do not afford an accurate judgment of the heat communicated, unleſs they be in contact with ſubſtances of the ſame kind as thoſe which ſurround the body, on which the chemical proceſs is performed; and laſtly, that with theſe attentions we may make an advantageous uſe of this inſtrument, of which the applications will not be ſufficiently known, until we ſhall be able to procure, at pleaſure, cylinders fabricated after the manner of Wedgewood, of a clay ſuſceptible of loſing 0,18 of its volume by contraction; or, which is the ſame thing (ſuppoſing no elaſtic matter to fly off), of paſſing from the ſpecific gravity of 2,05 to 2,45, between the degree of ignition required for baking the biſcuit of earthen ware, and the higheſt heat of furnaces, without undergoing a commencement of fuſion.

I have made a great number of experiments, with the intention of diſcovering a clay which might naturally exhibit theſe properties, or which might acquire them by eaſy and cheap preparation. I hope I ſhall be ſhortly able to communicate ſatisfactory reſults to the claſs of the inſtitute.

IX.

Deſcription of an Air-pump, of a new Conſtruction. By the Rev. JAMES LITTLE, *of Lacken, in the County of Mayo, in Ireland*.*

THE pump here deſcribed is a portable one, contrived ſo as to be confined in a very ſmall ſpace; but the author obſerves, that it may be made of a different form, and with two barrels, though not conveniently.

Fig. 1. plate XXI. is a perſpective view of the whole machine, as it lies before the operator. Fig. 2. is a back view of the ſame.

The barrel A A (fig. 1.) is almoſt fifteen inches long, and internally in diameter juſt two inches. The piſton (fig. 3.) is ſolid, without any perforation; it conſiſts of circular plates of leather, preſſed together between the round plate *a* (in the ſocket of which, *b*, the piſton rod was inſerted, and faſtened by a croſs-ſcrew, before the leathers were put on), and the two upper plates *c* and *d*; of which the outer one, *d*, being ſcrewed upon a ſcrew formed on the outſide of the ſocket, preſſes down the under plate, and this the leathers, which latter are not repreſented in the figure. The upper plate, when ſcrewed on, lies even with the upper part of the ſocket, that when the piſton is raiſed to the top, it may touch the plate covering the upper part of the barrel, leaving no air above the piſton. Theſe two plates of the piſton, eſpecially the lower one, are made ſo large as juſt to move in the barrel without touching it, and care was taken that when the piſton is put down, it ſhould be every where in contact with

* Iriſh Tranſactions. VI. 319. The paper from which the above is abſtracted, could not be given on account of its extent. It occupies 77 pages. Some of the early air-pumps were made with an horizontal barrel. There is a plate of one in Senguerdii Philoſophia Naturalis, the ſecond edition of which, in 4to, was publiſhed at Leyden, 1685.

with the plate at the bottom of the barrel, this plate being turned in the lathe upon the piston rod, which fitted its socket exactly, so that not the least space might be left for lodgment of air under the piston. The leathers are of the best buck-skin, dressed in the usual manner, firm in its texture, but not harsh; and, being well dried, were soaked in a mixture of three parts suet, melted with one part oil, before they were put together: they were then, when cold, turned in a lathe on the piston with a very sharp tool *.

The cylindrical iron rod of the piston is well finished, and moves through a collar of leathers. As it is altogether necessary that this rod should move most exactly in the middle, or axis, of the barrel, care was taken that the position of the box, and of the socket annexed to it, should be secured, by having a prominent part of the plate of the box of leathers inserted into the pump barrel, and a like projecting part of the lid of the box inserted into the box itself; also that the piston rod should most exactly fill the socket in the lid. Over the collar of leathers, within the box, lies a tinned brass plate, which is pressed down upon them by the ends of three screws 3 3, screwed through the lid of the box.

The piston is moved up and down by the toothed flat bar, or rack, F, whose end is furnished with an arm G (to be taken off occasionally), which arm is secured against a shoulder formed on the end of the piston rod by a nut H screwed on the rod; the rack is moved by a small steel wheel L, of twelve teeth, turned by the handle X on its axis L. This wheel is sustained by the cheeks K K, fig. 1. and 2. furnished with projecting sockets, through which its axis passes, and these cheeks are screwed to the iron bar M, which is a part of the frame supporting the whole machine; by this bar it is fastened by clamps to whatever table it is placed on. From the middle of the bar, and at right angles with it, extends horizontally an arm N (rivetted, and brazed upon the bar), the under surface of the arm being on a level with the upper one of the bar; this arm supports the gage-glass Y, and terminates in a cross-piece (making together the form of the letter T), to which piece and to the arm the receiver-plate is screwed by screws underneath, inserted into its thick margin.

The bar M supports the upright pieces, or pillars, *o*, *o*, terminating in the semicircular arms *p*, *p*, on which the barrel is fastened by four screws at *p*, *p*, screwed a little way into its projecting rings. These pillars are made of iron, and very strong, being half an inch in thickness; they are also most firmly fixed, and should be brazed in the bar which supports them; this being necessary, as all the force of the handle of the wheel, by which the rack is worked, bears against these pillars; and if they were to be shaken, the cement, by which the receiver-pipe is connected with the pump, would be broken, which cannot otherwise happen. These pillars support also the iron case, or sheath, P P, extended underneath the pump-

* If tanned leather were used for the piston, &c. it might be soaked in oil alone; but, besides that, it is apt to grow too hard by compression, and also to corrode the brass of the barrel more, from the acid imparted by the bark, with which it is tanned; it also emits a greater quantity of elastic fluid in vacuo than leather which is not tanned. On these accounts, I have used buck-skin leather for the piston; but the texture of this being very loose, oil only would not fill its pores, so as to make the piston air-tight, even when the leathers were closely pressed; and it was necessary to fill its grain with the above stiffer composition. Yet this leather will also generate air, and is harder to be made air fast; it also moves so stiffly in the barrel, that, perhaps, good shoe leather is preferable to it.—L.

barrel,

barrel, within which caſe ſlides the toothed bar, or rack, F, moved by the wheel, and this rack (with its caſe) is fixed exactly parallel to the axis of the cylinder, that it may draw out the piſton rod preciſely in that direction in which itſelf moves: the bar is $\frac{3}{10}$ of an inch in thickneſs, but is an inch in breadth from the bottom of its teeth to the back of it. It is made thus ſtrong, that the end of it may not be ſtrained upward from the proper direction, when it is urged forward by the wheel, and yet checked by the piſton rod, after the piſton is raiſed to the top of the barrel. To confine the rack in the true line of its motion, it is made perfectly ſtraight, and of the ſame dimenſions in its whole length, and its caſe the ſame, ſo as to fit each other moſt exactly, that it may be kept in its due poſition, when the greateſt part of it is drawn out of the caſe; for which purpoſe alſo it is made (as likewiſe the caſe) ſo much longer at either end than the part neceſſary to be toothed, as to permit a great part of it to remain in the caſe, when the piſton rod is drawn out to its utmoſt extent: accordingly in this pump it acts, in this reſpect, as well as could be wiſhed*. A notch is cut out of the caſe at I, to allow the teeth of the wheel to take into thoſe of the rack; and to keep the caſe firmly in its place, little notches are cut in the upper edge of it, into which the contiguous parts of the pillars are let, and it is ſecured ſo by wedges, 2 2, underneath. It will be known that the caſe of the rack has its due poſition, when the arm G being taken off, both the rack and the piſton rod pulled out to their limit, are found to be parallel. The pillars are made as ſhort as poſſible; to favour which the frame M has a furrow cut in the middle of it, under the wheel I, to let the teeth of the wheel deſcend almoſt to the table on which the machine reſts; and the pump barrel is placed as near as may be to the rack.

On the upper part of the box, containing the collar of leathers, is a projecting part of the metal, in the ſhape of a cube, forming a little pedeſtal Q: on this is placed the valve *f*; from beneath which deſcends a ſtraight duct into the barrel, without penetrating the box: the form of the parts of this valve (all made of braſs, and of the ſize of the originals belonging to the pump) is repreſented in fig. 4. in a vertical ſection. A A is a ſquare plate (to be taken off if it ſhould require to be ground and poliſhed anew in contact with the valve), which is faſtened on the pedeſtal with cement; it has a hole in the middle, being the opening of the duct, in which is inſerted the little elevated pipe *c*, to be occaſionally taken out; whoſe uſe is to prevent the oil applied to the valve from being blown down into the duct by the air ruſhing into the barrel: the elevated part of the plate *a*, *a*, is circular, and has its upper ſurface made plane and poliſhed, on which reſts the valve D; which is ſo far hollowed within, that only its lower edge, being about $\frac{1}{30}$th of an inch thick (which is alſo well poliſhed), may be in contact with the plate under it, and alſo that its cavity may riſe above the little pipe: the valve

* By this contrivance of fixing the barrel of the pump horizontal, and its rack underneath the barrel, it is made ſo portable, that I have packed it (the gage-glaſs and receiver being taken off) in a box two feet long, eighteen inches wide, and ſeven in depth; and it ſhould be remembered that the moſt operoſe parts of it here deſcribed, are the frame and machinery neceſſary to render a pump, with *ſo long a cylinder*, portable; a great part of which machinery, if it were not portable, would not be ſpared, but merely exchanged for the huge frame of thoſe ſo conſtructed.—L.

is

is almoſt cylindrical, tapering but a little from the baſe upward, and being laid on the plate, with a ſmall drop of oil interpoſed, the hollow cylindrical cap E, very little wider internally than the valve, is put over it, being faſtened down on the projecting circular part of the plate *a a*. To let the air paſs through this cap, three little holes, *e, e*, are made in its ſides, the centres of which are juſt as high as the lower edge of the valve D, when it is raiſed to touch the top of the cap; the holes being higher than the plate under the valve, that the oil may not run out by them. When this valve is found to admit air into the barrel, it is occaſioned either by the oil's being blown away, or ſome particle of duſt, &c. getting between it and the plate (which would produce the ſame effect in any valve), and is remedied by taking it off, wiping it clean, and applying another drop of oil: the greater the quantity of air is, which paſſes by the valve, the more is the oil diſſipated; and, conſequently, this chiefly happens in the beginning of the exhauſtion, when much air is drawn from the receiver, and thrown out of the barrel at each ſtroke; ſo that whenever great rarefaction is requiſite, I often found it convenient, towards the end of the operation, to apply a freſh drop of oil to the valve, keeping the piſton in the mean time elevated to the top of the barrel, whilſt the valve is taken off, until it be replaced; which is done in an inſtant: thus it will perform perfectly well if quite clean and free from duſt; but as the ſmalleſt particle of dirt, or mucus (which is apt to be produced from the oil's corroding the braſs, and becoming clammy), will render the valve not air-tight, I am, therefore, perſuaded, that no valve will ſo perfectly or certainly exclude air as a ſtop-cock; and this I take to be the chief reaſon why Mr. Smeaton's pump, as improved by Meſſrs Haas's and Hurter's contrivance, for raiſing the valve at the bottom of the barrel, does not, in practice, anſwer as well as any other: for if ſome air did not return into the receiver by that valve in pumps on his conſtruction, it would be hard to tell why it ſhould not perform as well as a pump of any other conſtruction.

To the bottom of the barrel is faſtened by four ſcrews, paſſed through its prominent rim, the circular plate R, forming in part the ſhell of the cock S, and which has the high ridge T on the back of it; all theſe being only one piece of metal, which is repreſented ſeparately in fig. 5. and was caſt in that form: the round plate is about $\frac{1}{4}$th of an inch thick; but the cavity of the cock intrudes ſo far on this, that when the key of the cock is put in, the thickneſs of the plate in the part directly over the key, where the ducts open into the barrel, is not more than $\frac{1}{8}$th of an inch: the length of the ſhell of the cock is three inches; that of the key $\frac{1}{8}$th of an inch leſs: the diameter of the key at the thicker extremity is 1 $\frac{4}{10}$ths of an inch, and at the ſmaller end 1 $\frac{1}{4}$th of an inch. It is turned by the handle *u*, faſtened on its axis as near to the end of the ſhell as may be; viz. at the diſtance of $\frac{1}{4}$th of an inch. Care was taken that the metal of the cock ſhould be free from pores, by which, if air were admitted in the working, it would be very hard to diſcover it, as this might take place only in *certain poſitions* of the key; and the ointment might ſometimes prevent and ſometimes ſuffer it, ſo that it might elude trials; the cock was alſo ſo truly and ſmoothly ground, as to produce an intimate contact of the key and ſhell throughout (for air will penetrate where liquids would not); it was alſo made of a true conical ſhape, its ſides being perfectly ſtraight from end to end. The cock

muſt

muſt be lubricated, and made air-tight by ointment *; and as all oil or greaſy ointment has an acid in it (of which, perhaps, it can never be diveſted without deſtroying its lubricity) which corrodes the braſs, and ſtiffens the oil or ointment itſelf, by impregnating it with green ruſt or verdegris, I found it neceſſary, after the cock was finiſhed, to have the key and the inſide of the ſhell coated with tin.

The key of the cock terminates in a little knob *x*, fig. 2. againſt which the end of the thin ſpring lever *y* preſſes to keep the key conſtantly firm in its ſhell: this ſpring is made to urge onward the key, with any degree of force requiſite, by the ſcrew at *y*, ſcrewed through the outer part of the little arch, or frame, which frame is itſelf faſtened by ſcrews on the prominent ring of the barrel, as appears at *z*, fig. 2. The lever has a little ridge, or elevated part, which reſts in a notch in the frame; by which the lever is fixed in its proper place, the notch being the fulcrum: by withdrawing the ſcrew the ridge may be raiſed out of the notch, and the lever pulled back from the knob, to let the key be taken out when it requires more ointment; which will be known when it has worked into the ſhell nearly to its limit; and this ſhould be carefully learned, by marking how far it can be inſerted into the ſhell without any ointment interpoſed. The form of the key, and its lever, is exhibited in fig. 6. in an horizontal ſection through the middle of them.

Through the ſhell of this cock are two round perforations for two ducts, through the cock, each one inch diſtant from the other, and the ſame from the end of the cock on either ſide: they are in a plane, or ſection, paſſing through the axis of the key, and alſo through the axis of the barrel; and both paſs through the ridge of metal T at the back of the ſhell. The duct next the ſmaller end of the key (being a part of the duct communicating with the receiver) is in diameter $\frac{1}{4}$th, and the other duct is only $\frac{1}{6}$th of an inch: through the key, alſo, are ducts anſwering to the perforations in the ſhell; but the ducts in the key are not both in the ſame ſection of it, but one of them is at right angles to the other; ſo that when one of the ducts through the cock is open, the other will be always ſhut, and *vice verſâ*.

There is a continuation of each of thoſe ducts formed in the piece of metal V, which is joined (by cement interpoſed) to the ridge of the ſhell of the cock by the four ſcrews *g*, *g*, fig. 1. by two openings (into the two ducts in the piece of metal) oppoſite to thoſe in the ridge; and theſe ducts in the piece V have two other orifices at *a*, and *c*, where the two pipes *a b*, fig 1. and *c d*, fig. 2. communicate with the two canals in the piece of metal, being connected with them only by the help of cement, that the barrel with its cock may be occaſionally disjoined from them: thus a ſeparate communication is formed between each of the pipes, and the barrel.

The pipe *a b* is only $\frac{1}{10}$th of an inch in diameter, except at its orifices, which are widened,

* This I have made of one part of common roſin, one part oil, and one part and a half freſh ſuet: the oil and roſin is firſt melted, and when a little cooled the ſuet is added, that the heat requiſite to melt the roſin may not burn the fibrous part of the ſuet, and deſtroy its firmneſs: more oil is to be added in cold, than in warm weather. The quality of the ointment for the cock is of the utmoſt conſequence; for if ever the parts of the metal of the cock came into immediate contact, it will not be air-faſt; oil will not render it ſo (nor conſequently would a valve); but the ointment muſt be ſtiff and adheſive; yet not too ſtiff, as then it would be hard to turn the key, and it could not be diſtinguiſhed whether its ſtiffneſs was owing to the ointment, or to the friction of the parts of the metal getting into immediate contact, which would be pernicious.—L.

one

one of them is connected at *b*, with a duct formed in the piece of metal *k*, attached to the box of leathers C at the top of the barrel, which duct turning in an angle, without penetrating the box, opens into the barrel: this pipe and duct are joined by a simple application of their orifices, which are made in the contiguous sides of both, and the joint made air-tight, by cement melted around with a blow-pipe; and the same might be effected by the pressure of a screw closing the surfaces with oiled leather interposed. By this pipe when the valve is shut, and the key of the cock so placed that the communication of this pipe with the bottom of the barrel is open, if the piston be depressed from the top, all the air which is *under* it will be forced to pass by this pipe into the barrel *above* the piston; and *vice versâ* if the piston be elevated from the bottom; so that according to the motion of the piston, the air under, or over it, within the barrel, is made to change its place, and to circulate from the space under or above the piston to the contrary; from which effect of this pipe, I call it the *circulating pipe*.

The other pipe, or duct, is represented at *c d*, fig. 2. which exhibits a back view of the pump: its extremity *c* enters the block of metal V to communicate with the duct therein, and so with that through the cock into the barrel: its end *c* has a wing soldered to it, by which it is firmly screwed to the piece V; this being necessary lest the cement by which alone the joint there is made air-fast, should be cracked by any shock moving the barrel; or it might, perhaps, be secured by the screw with only leather interposed: this duct is a very wide one, that the air may the sooner pass through it; it has a turn at right angles at *d*, and another at *e*, from whence it extends under the pillar B, and pump-plate C D, through the middle of which it rises at A; it has a branch turning at right angles from A under the pump-plate, the end of which terminates in a round orifice with an inside screw, that by means of a pipe furnished with a stop-cock; or otherwise another pump-plate and receiver, or several of them, may be connected with it, being laid on the same table which supports the pump: when such are not used, the orifice is closed with a stop-screw as at D. From this pipe rises a branch E, inserted into the top of the brass cap F of the glass vessel Y, and opening into the vessel by a duct made in the thick plate of the cap. G is a reduced barometer tube, to be filled in the most perfect manner with mercury, and immersed into a pool of mercury in the bottom of the glass vessel. The interval between the tube and the neck of the vessel is closed by cement, which, as the neck must be a good deal wider than the tube, is effected by a deep ring (I) fitted to the tube, having a round plate at the bottom of it; which being let down on the tube after it has been immersed in the cistern, is joined with cement to the top of the cap. The tube was easily immerged in the mercury within the vessel, by covering its open end, and sustaining the mercury in it by a little plate, or scale of iron (P), fig. 7. having two threads tied to it, through two holes made near its edges; which threads were grasped together with the top of the tube between the fingers, and the tube was inverted, and let down into the mercury in the vessel: the little plate was then pulled up by one of the threads, it being made so small as to pass through the neck of the glass while the tube was within it, and remained immersed in the mercury*: the vessel

* I thought this the best way of fixing the reduced barometer, for if there were a separate vessel as a cistern for the mercury, and a receiver placed over it and the tube, the eye when on a level with the surface of the stagnant mercury, could not see the altitude of that in the tube with precision through two glasses.—L.

vessel was then closed at the top with melted cement; and as it communicates by the pipe E with the conduit-pipe, it is exhausted with the receiver, and the mercury in the tube will sink as the rarefaction advances: if a perfect vacuum could be made in the receiver, and gage-vessel, it would sink more or less *beneath* the level of the surrounding mercury, as the tube is narrower or wider, even so as to disappear if the tube were very narrow; so that it must not be less than $\frac{3}{10}$ths of an inch in diameter; but it would be better if it were $\frac{4}{10}$ths. If it were observed, how much the mercury in a tube open at both ends would sink beneath the level of that in a cistern in the open air, it might be pretty nearly estimated how great is the rarefaction in this gage-vessel, and consequently in the receiver*.

In order that each of the ducts here described should alternately communicate to the barrel, it is necessary, that the cock should be moveable through a quarter of a turn, and confined to that motion. This is effected, by a pin, *n*, fixed perpendicularly in the back of the handle, fig. 1. which, when the handle is fixed in its place, describes a quadrantal arc, under the shell of the cock, where there is just room to allow such a motion.

The action of this pump may be readily apprehended from the construction of its parts. When the piston is at the bottom of the barrel, and the key of the cock turned to its limit which opens the communication, between the barrel and the receiver and at the same time shuts that with the circulating pipe; the piston being then drawn to the top of the barrel discharges the air through the valve, while other air from the receiver rushes into the barrel, and follows the piston. As soon as the piston has arrived at the upper, or more remote end of the barrel, the key of the cock is again turned, and shuts off the connection with the receiver, and opens that with the circulating pipe. The piston being then depressed, drives the air through the pipe, into the upper, or remote end of the barrel. When the piston has arrived at its limit, the stroke is ended, the key of the cock is to be again turned to open the receiver, and a second stroke may be made, with the same consequences as the first; and in this manner the process may be continued at pleasure. The limit of exhaustion will be when the air in the receiver shall have become as rare as the air in the barrel would be when the piston is up; supposing no communication to have taken place between it and the receiver.

When the pump is required to condense, the air is made to move in a reverse direction. The cock of the gage-vessel is stopped, that it may not be burst; the valve is taken off; the communication of the bottom of the barrel, to the circulating pipe, opened by the key of the cock, and the piston raised to the top. The external air passes into the lower part of the barrel; and by turning the cock, so as to open the receiver, and shut the circulating pipe, and then depressing the piston, the air is forced into the receiver, which ought of course to be of sufficient strength, and properly secured. By shutting the receiver, raising the piston, opening the receiver again, and returning the piston to its former situation, another stroke is made, and these alternations may be carried on to any desired or practicable extent.

* The author prefers the short barometer-gage to the syphon-gage, because in this last he thinks the motion is impeded by the tube, and the mercury becomes foul on that side which communicates with the receiver.—N.

The

The remainder of Mr. Little's paper, conſiſts of numerous obſervations and remarks, with ſome experiments; a conſiderable number of the former of which are familiar to ſuch as have attended to this branch of natural philoſophy: but the whole, though evidently ſhort of what the author muſt have originally intended, will be read with intereſt and ſatisfaction, by thoſe who may conſult the memoir itſelf.

X.

Obſervations on Chemiſtry and Natural Hiſtory. By PROFESSOR VANDELLI*.

1. *Foſſil Pruſſian Blue from Minas Geraes in the Brazils.*

IN digging a mine at S. Ioao del Rey, to the depth of more than forty palms (about 27 feet Engliſh), large brittle bones, and ſome teeth of a cetaceous animal were found in the clay, which occupied a ſpace of more than fifty palms ſquare (about 35 feet Engliſh). Theſe bones, and the clay with which they were intermixed, were white when firſt extracted, but ſoon became blue when expoſed to the air †.

Theſe bones and clay, in the blue ſtate, being expoſed to the action of a moderate fire, became green, emitted a weak flame, and afterwards loſt their colour. The reddiſh earth which remained was, for the moſt part, attracted by the magnet.

The Pruſſian blue was ſoluble in the marine acid, and in this ſtate loſt its colour. By addition of a fixed alkali, the precipitate was afforded of a green colour, which afterwards became blue, of more intenſity then at firſt.

The mixture of bones and clay, being fuſed with a proper flux for iron, afforded three parts of their weight of iron, which was intirely attracted by the magnet.

Reſpecting the foſſil Pruſſian blue, as the reader may conſult the works of Wallerius, Bergman and Kirwan, I ſhall not enter into any further detail.

2. *Native Copper of Brazil.* This maſs of copper was found in a valley two leagues from Cachoeira, and fourteen from Bahia. It weighs nearly 2616 arratels (or nearly pounds Engliſh), and its figure is rhomboidal, the upper ſurface being irregular, on account of ſome cavities and protuberances. Its greateſt height is three feet two inches, its width, at the baſe, two feet and a half, and its greateſt thickneſs ten inches, Paris meaſure ‡.

The external colour of the maſs is deep reddiſh, with ſpots and particles of a greeniſh blue, produced by the decompoſition of the copper. On the lower ſurface appear ſome yellow ſpots of ochre of iron.

At various parts of the ſurface, particularly the lower ſurface, ſeveral pieces, large and ſmall, are obſerved, which, at firſt, ſeem to be *ferrum micaceum*; but when examined by fire they prove to be indurated oxide of copper. For an ounce of this ſubſtance afforded thirteen parts out of ſixteen pure copper.

* From the Tranſactions of the Royal Academy of Sciences at Liſbon, I. 259.

† For an explanation of this phenomenon, ſee Prouſt in this Journal, I. 455.

‡ The foot-royal of Paris is to that of London as 1,0000 to 0,9383.—N.

This

This copper being assayed, afforded no indications of gold or silver.

Another piece of virgin copper was found at the same place, but much smaller than the former. A mass of native copper, of the magnitude here described, has very rarely been met with, as Mr. Monnet remarks*.

XI.

On the Manufacture of Hats, and other Objects. By a Correspondent.

To Mr. NICHOLSON.

Newcastle, 9th January, 1799.

SIR,

THE obliging manner in which you have noticed my enquiries, respecting the hatting business, induce me to send you others on another business, equally productive of mischief, to the morals and the health of a class of industrious, but depraved, fellow men—I mean the journeymen flax-dressers; those and the journeymen hat-makers, are almost proverbially vicious, and I confess I look with sanguine expectations of reform, to the period that will exhibit machinery for each.

Is it possible to construct a machine, for the purpose of dressing flax? There are machines, I understand, in Scotland, invented about 40 years ago (vide English Encyclopedia, article Flax Dressing), for the breaking and scutching of that article: might these not be extended to the farther process of the heckles? Perhaps the claim is equally upon humanity as ingenuity, for I have been told (and I have, from my own knowledge in that business, scarce any doubt of its truth), that the journeymen are obliged to give it over, about the age of 40, from an approach of *consumption*; and one, whom I am told was lately opened at his death, *had his lungs covered with a thick crust, composed of the dirt received upon them from his business.*

Accept the following information, as the best I can yet afford you, on the subject of my queries in your last (p. 467); they have been obtained since my writing to you on the subject. Hats were invented at Paris, A.D. 1404, by what circumstance I am yet ignorant. Felt made in London, 1510. The above, though an anonymous communication to me, I believe will not be found far from the truth. There is a house in Derbyshire, name Cooper Bibby and Downal, at Lea Wood, near Cromford, in that county, who, I understand, use machines in the making of hats, but how far in the process I am not yet able to discover: perhaps some of your correspondents may have informed you, in consequence of my queries. The common account amongst the journeymen is, that *the property of wool to felt* was first discovered by a shepherd, who had wool in his shoes; his name was Clement, and they keep the 25th of November, as a day *sacred to dissipation and an old shepherd saint.* Saint Catherine, I understand, is the patroness of the journeymen flax-dressers. It is probable, *they* will celebrate the 25th of November.

* Nouveau Système de Mineralogie, page 314, Mines de Cuivre. The Cabinet of Mines at Freyberg possesses a specimen of this kind, weighing ten pounds, which is the finest and largest specimen of native copper hitherto known.

These

These ſuggeſtions may, I hope, afford a thread to others, more converſant in the t[illegible] Mahuzzim, or ſaints protectors, than I am, to favour you with information of more conſequence on the ſubjects of the manufactories in queſtion. The editors of the Engliſh Encyclopedia ſay, that, on the ſubject of dreſſing flax, they refer their readers to ſome obſervations in the Gentleman's Magazine, for June, 1787: I have not that book at hand, but I hope your readers may find in it ſome ground-work for future machinery.

I am, ſir,

Yours, &c.

N. L.

In the liquor for boiling of wool hats, after bowing and baſoning, one part of human urine is made uſe of, and two parts clean ſoft water: Could not ſomething be ſubſtituted in place of the urine, which might be *equally uſeful in hardening the hood*, and exclude ſo dirty an ingredient*?

XII.

Extract of a Letter from Citizen Ramond, Aſſociate of the National Inſtitute of France, and Profeſſor of Natural Hiſtory at Tarbes, to Citizen Haüy, Member of the Inſtitute at Paris, reſpecting two excurſions to Mount Perdu, the moſt elevated ſummit of the Pyrenean Mountains†.

Bareges, 5 complem. day, in the year V.

I FLATTER myſelf, Citizen, that you will not hear, without intereſt, ſuch events as have proved moſt remarkable in the reſults of my travels of the preſent year. I haſten to communicate them, with the hope that the portion of your time which I ſhall engage will be well repaid by the geological fact which is the object of this letter.

Mount Perdu is the moſt elevated mountain in the chain of the Pyreneans. In my former travels, I proceeded along the baſes. Reboul, who has ſucceeded in determining its height by obſervations made from various elevated points, had likewiſe approached it in a different direction. It is certain that the whole of the ſurrounding group is calcareous, and the aſpect, which can ſcarcely deceive thoſe who are habituated to behold and contemplate mountains, had determined my belief that the entire pic was of the ſame nature.

Abundance of calcareous matter forms one of the diſtinct characters of the Pyrenean mountains; but to behold this genus in poſſeſſion of the very creſt of the chain, the place which the granite occupies in every other known chain of mountains, was a phenomenon too ſingular not to inſpire me with the ſtrongeſt deſire to aſcertain its exiſtence.

The enterprize was not without its difficulties; and among them, that which was the leaſt

* The preparations for my change of reſidence, as mentioned on the wrapper, have induced me to defer my own obſervations and report, concerning hatting, till next month.—N.

† Read to the French National Inſtitute at the ſitting of the 21ſt Vendemiaire, in the 6th year of the Republic (12th October, 1797), and inſerted in the Journal de Mines, No. 37, of the ſame year.

foreſeen,

feafon, was the abfolute ignorance in which I found all the country people, with regard to the real pofition of Mount Perdu. It is not vifible, but from the elevated fituations, and difappears as foon as you defcend. It was neceffary, therefore, to feek the road, as chance might direct, through the moft horrid deferts, which are never frequented, either by the hunter, or by fhepherds.

On this occafion, I had the good fortune to enjoy the company of our colleague, La Peyroufe; and I ufed every effort in my power to fecure his company in thofe regions, in which I forefaw fo many interefting obfervations would prefent themfelves. But his ftrength did not permit him to accompany me longer than the firft day, and part of the fecond. I left him at the foot of the firft glaciere, taking with me his fon, and one of his pupils, together with four of my own. I will not fatigue you with the detail of our own fufferings, nor alarm you with an account of our dangers; but fhall fimply obferve, that after having imprinted our fteps, during three hours, in the hardened fnows, which the inclination of their plane rendered very dangerous, we arrived at a fummit oppofite Mount Perdu, which raifed us to its middle part. I never beheld, even in the Alps, any object of greater magnificence: I do not except the approaches to Mount Blanc. The calcareous mountains poffefs a fimplicity of form and majefty which is peculiar to them: now Mount Perdu is calcareous, abfolutely calcareous, and of fecondary compofition. I defcended from my fituation towards a vaft lake, ftill frozen, which repofes at its feet. I croffed this lake; I vifited every fpot where the eternal fnows, and horrid glacieres, have fuffered the naked rocks to penetrate. Every where I found grit, breccia, and compact calcareous ftone, covered with the prints and remains of marine bodies: marine remains at the fummit of the Pyrenees, and on the pic which predominates over all thefe mountains!—This phenomenon acquires a character ftill more wonderful, when we confider that the entire chain exhibits none of thofe atteftations of the former refidence of the ocean; and that it is in vain we feek them in our fecondary calcareous ftones, our bituminous ftones, or flates, all which are deprived of the prints of fhells and vegetables. I paffed from the flanks of Mount Perdu into the valley of Pinede, where it pours its waters; I came to the port or paffage of Pinede, one of the moft elevated of the Pyrenees. The fame phenomena every where prefented themfelves; every where I faw grit, breccia, and common calcareous ftones, abounding with marine bodies; and by cafting my eyes along the extenfive valley of Pinede, I faw, in all parts, the continuation of the banks in which I had obferved thefe remains.

La Peyroufe had feen the oppofite fide of the mountains which I vifited: he coafted along them to meet me at the port of Pinede. He obferved part of thefe wonders, and partook of my harveft. Stormy clouds having covered the pic, at the time of my arrival at my firft excurfion, it became neceffary to revifit it at a more favourable feafon; I, therefore, refumed the route of Mount Perdu, fifteen days ago, with a couple of friends only, and fome hardy mountaineers. All the glacieres were then uncovered, by the diffolution of the fnow which had laid upon them; the lake was unfrozen, and the dangers of approach were confiderably increafed. It was neceffary to fecure our footfteps in the hardeft ice by heavy ftrokes of the hatchet. We fuffered much in this excurfion, and I could not reach the fummit; but the fky was admirably ferene, and I touched, as it were, thofe rocks which I could not afcend.

aſcend. At this time, I beheld the whole ſtructure of the mountains, the direction and inclination of the ſtrata, the entire ſucceſſion of its layers; every fact was manifeſted to my ſight, and I completed my collection of marine bodies, which are contained in theſe mountains.

To the weſt, as well as to the eaſt, every part is ſecondary, and full of ſhells. I ſent one of my pupils towards Vignamale, who brought me a cornu ammonis. It is, as I have ventured to affirm in my printed obſervations, an enormous ſecondary maſs, ſuperpoſited on the edifice of the chain, and which covers the ſouthern part to the thickneſs of ten or twelve kilometres, and is in length, forty.

The moſt perfect among the remains of marine bodies which I found in theſe regions is a perfect ammonite, the exact impreſſion of a pectinite, the prints of aſterites, many oyſters in the ſolid, caryophillites, and a multitude of madrepores. I ſhall not enter into more circumſtantial details. The geologic and geographic reſults; the nature and inclination of the different banks; their connection with the rocks which ſupport them; the ſtate of vegetation; the inſects obſerved in theſe elevated regions;—will form materials for a memoir, which I intend to draw up, when in a leſs interrupted ſtate, for the purpoſe of tranſmitting it to the National Inſtitute. But I am deſirous that the principal facts ſhould be communicated to that body, with all the intereſt of novelty, and I think them ſufficiently intereſting to requeſt your mediation in this reſpect.

If you think it proper likewiſe to tranſmit them to the Council of Mines, I requeſt that you will permit me to give you the trouble of performing this office.

XIII.

An Abſtract of a Memoir upon the Foſſil Bones of Animals. By Citizen CUVIER.*

THE intention of the Author, in this memoir, was to collect as much as it was in his power all the foſſil bones appertaining to each ſpecies of animal, whether of ſuch as he himſelf had ſeen, or thoſe of which he merely had a deſcription in authors, to form or recompoſe the ſkeletons of theſe ſpecies, and to compare them with thoſe which now exiſt on the ſurface of the globe, in order to determine their relation and differences. The following is a ſeries of the ſpecies to which his attention has been directed.

1. The animal which afforded the bones and teeth, called the bones and horns of the mammouth, by the Ruſſians, and inhabitants of Siberia. Similar foſſile remains are alſo found in Europe. It is a ſpecies of elephant, reſembling the elephant of Aſia; but from which it differs in the alveolæ of its teeth, and its tuſks being longer, the angle of its lower jaw

* Communicated to the Societé d'Hiſtoire Naturelle at Paris. This abridgment is tranſlated from the bulletin of the Societé Philomatique, No. 18, year VI.

being

being more obtuſe, and the laminæ of which its grinders are compoſed being thinner. The analogous living animal is not known, though it has been hitherto conſidered as the ordinary elephant.

2. The animal, of which the remains are found on the banks of the Ohio in North America, which the Americans and Engliſh have alſo named mammouth, though it differs much from the former. Remains of this animal are alſo found in Europe and in Aſia. It muſt have been nearly the height of the elephant, but more bulky; its tuſks are ſmaller; its grinders are armed with large cutting points, of which the ſection by wear preſents double tranſverſal lozenges. There are three molar teeth on each ſide, one of four, one having ſix, and one eight, points.

3. The animal of which the teeth tinged by copper afford the turquois ſtone, and of which there was a mine at Simore, in Languedoc. The remains of this ſame ſpecies is found in the department of Ain, in Peru, and elſewhere. It muſt have conſiderably reſembled the former, but the points of its molar teeth are round, and when worn, their ſection preſents, firſt, a circle, then a ſemi-oval, and afterwards, a figure of a trefoil, which has cauſed them to be confounded with the teeth of the rhinoceros: ſome of theſe teeth have twelve points, others ſix, others four.*

4. The rhinoceros. The feet and fragments of the jaws of this animal are found in France, and elſewhere, in which the author has hitherto obſerved nothing which differs from the common rhinoceros; but, as he has not yet ſeen an entire bone, he cannot poſitively affirm that they are identical.

5. The ſpecies of rhinoceros, with an oblong craneum, which is found in Siberia, Germany, and other countries. The author has ſeen teeth, and parts of the jaw-bones, found in France, which appeared to him likewiſe to belong to this animal; the principal character of this ſpecies conſiſts in the long cloſure of the noſe: the living analogous animal is unknown.

6. A molar tooth with two tranſverſal eminences, which is in the poſſeſſion of Citizen Gillet; and of which the National Muſeum poſſeſſes a young tooth that reſembles neither the teeth nor the germs of any animal yet known, whether living or foſſile: the only tooth which this ſlightly reſembles is the laſt molar tooth of the rhinoceros. This tooth, therefore, indicates the exiſtence of a ſixth foſſile ſpecies, of which the living analogous animal is unknown.

7. The animal, twelve feet in length, and ſix in height, of which the ſkeleton was found under ground at Paraguay, and is preſerved in the royal cabinet at Spain, at Madrid. The author proves by a detailed compariſon of the bones, with thoſe of all the known quadrupeds, that it is a proper and diſtinct ſpecies, more nearly approaching the ſloth than any other genus, and that it may be called the giant ſloth. Citizen Cuvier, in this place, communicates the intereſting diſcovery he has made, that the ſloth (*bradypus tridactybus*. Lin.) has naturally and conſtantly nine cervical vertebræ. It is the firſt known exception, eſtabliſhed by Citizen Daubenton, that all quadrupeds have neither more nor leſs than ſeven cervical vertebræ.

8. The animal, of which the remains are found in the caverns near Gaylenreuth and Muggendorf, in the margraviate of Bayreuth, in Franconia. Various authors have conſidered

dered it as a white bear; but it differs from this animal, as well as from all the known bears, in the form of its head, which is particularly characterized by the projection of the front, by the absence of the small tooth, which all the known bears have behind each canine tooth, by the osseous channel of the humerus, in which the brachial artery passes; and by several other circumstances in the figure and proportion of the bones. This animal, however, resembles the bear more particularly than any other kind.

9. The carnivorous animal of which the bones are found in the plaister-stone of Montemartre: the form of its jaws, the number of its molar teeth, and the points with which they are armed, indicate that this species is referrible to the genus canis; but it does not completely resemble any species of this genus. The most striking distinctive mark is that the seventh molar tooth is the greatest in the animal of Montemartre, whereas the fifth is the largest in dogs, wolves, foxes, &c.

10. The animal of which the lower jaw was found near Verona, has been considered by Joseph Monti as a portion of the cranium of the sea-cow; a notion which all the geologists have adopted, though it be the contrary to the most simple notions of comparative anatomy. This jaw, according to Cuvier, has belonged to an animal resembling, though specifically different from, the mammouth, the animal of the Ohio, and that of Simore. Its most particular character consists in the curve which forms its symphysis.

11. The animal of the stag kind of which the bones and the antlers are found in Ireland, in England, at Maestricht, &c. It is sufficiently different from all the stags, and even the elk, to which it has been referred, by the enormous magnitude of its antlers, the flattening of their superior part, and the branches which spring from their base. Several figures of these are given in the Philosophical Transactions.

12. The genus of the ox or beeve alone affords several fossil species: the craniums of two were found in Siberia, which have been described by Pallas, who referred one of them to the ordinary buffalo; but he has since attributed them to a peculiar species, natives of Thibet, named arni. Citizen Cuvier proves, by osteologic comparison, that those craniums have not belonged to the buffalo. The other appeared to Pallas to have belonged to the buffalo of the Cape, or the musk ox of Canada. Citizen Cuvier shews that they cannot have belonged to the former, but not being in possession of the cranium of the arni, nor the musk ox, he makes no decision respecting their identity with the fossile craniums.

The author likewise describes two kinds of craniums which have been found in the turf pits of the department of La Somme, which greatly resemble our common ox, and that of L'Aurouchs, but are more than one fourth longer.

From this enquiry, the Citizen Cuvier concludes, 1. That it is not true to affirm that the animals of the south have formerly lived in the north, their species not being perfectly identical. 2. That in every country there have lived animals which do not at present exist, either on the same spot, or elsewhere in any known country. Hence he leaves to geologists, the task of making, in their systems, such changes or additions as they may think best suited to explain the facts which he has thus established.

XIV.

Extract of a Memoir of Proust, entitled Enquiries concerning Tin. By CITIZEN DARCET.*

THE author of this memoir obferves, in the firft place, that he confiders his work as a fupplement to that of Pelletier, on the different degrees of oxygenation which tin can acquire, when diffolved in acids.

When tin is diffolved without heat, in very weak nitric acid, it acquires a degree of oxygenation, different from that which it would obtain if diffolved in a concentrated acid, or if heat had been employed. In the firft cafe, the nitric acid is not decompofed, and affords but little oxygen; but this is not the cafe with the water, which in fact, affords the quantity neceffary for its oxygenation.

This folution, which is of a yellow colour, gradually precipitates, more efpecially if it be heated, and the feparation of the tin is made without re-action, for there is no difengagement of nitrous gas; and if it be faturated with cauftic pot-afh, there is a difengagement of ammoniac, as was already obferved by Bayen and by Pelletier. The oxyde of tin, as well that portion which remains fufpended in the fluid, as that which is precipitated, and re-diffolved in muriatic acid, equally decompofe the fuperoxygenated muriate of mercury, and the mercurial oxydes, &c. being very different, in this refpect, from *the oxyde of tin, which is precipitated from the* folution, in concentrated nitric acid, or the folution which has been made *with heat.* In this, the nitric acid is decompofed, and the precipitate is infoluble in the muriatic acid, and no longer acts upon corrofive fublimate, or the oxydes of mercury. This difference arifes from the circumftances, that in the firft cafe, the oxyde of tin, whether it remain in the liquor, or fall down, is oxyded to the minimum, as Prouft affirms, and in the fecond cafe, to the maximum. Hence it is, that in the firft cafe, there is no difengagement of elaftic fluid, whereas in the fecond, the difengagement is confiderable.

When an acid of the ftrength of 25 or 30 degrees is ufed (fp. gr. 1,23), the folution is fo violent, that there does not remain an atom of tin in the fluid, but the precipitate is oxyded to 40 parts of oxygen; but when the very weak nitric acid is ufed, or the folution is made without heat, the metal is oxyded only to 30.

It is afcertained by hepatic water, that all the tin is feparated from the acid; for this re-agent, will totally precipitate tin, copper, or lead, if the fluid contain any. Prouft has obferved, that this re-agent may prove eminently ufeful. For example, fuppofe a folution to contain lead, copper, zinc and iron, the hepatic liquor will feparate them all in fucceffion; firft the copper, then the lead, next the zinc, and laft of all the iron, with this remarkable event, that the iron which was oxyded to the maximum in the folution, is thrown down at the minimum, and is precipitated green, by ammoniac and by lime. This happens, becaufe the hepatic water feizes a portion of the oxygen from the oxyde, and becomes decompofed, leaving the iron at the lefs degree of oxygenation.

It is known, that very fetid hydrogen is extricated, during the folution of tin in the muri-

* Annales de Chimie, XXVIII. 213.

atic

atic acid, particularly when the tin contains arſenic, which may be very well aſcertained, b burning the gas under a glaſs veſſel, when the arſenic is depoſited on the ſides. Prouſt all obſerves, that this gas is very hurtful to the brightneſs of the purple of powder of caſſiu. He therefore very properly adviſes, that the ſolution ſhould be heated before it is uſed: a obſervation of the greateſt importance for porcelain and enamel painters.

If a few drops of the muriate of tin, be added to the muriatic acid of commerce, th yellow colour of the latter inſtantly diſappears. The tin deprives the iron of the exceſs o oxygen, which rendered it red, and ammoniac then precipitates it of a green colour. The ſam thing happens with the ſolutions of the ſulphates, nitrates, and red muriates of iron.

But, if a ſtronger doſe of muriate of tin be poured into the muriatic acid of commerce, a grey powder falls down, which Prouſt has aſcertained to be mercury.

When a ſolution of the muriate of tin is diſtilled, the whole of the liquid comes over, wit a portion of the muriate. Towards the end, the matter ſwells up, and afterwards ſettles in th ſtate of calm fuſion, of a green colour; and if the fire be raiſed, puffs of fuming vapour ar driven off, but nothing comes over in the fluid form. If the muriate of tin contains a ſmal portion of ſulphuric acid, that acid is decompoſed, and the ſulphur partly unites with the tin forming a ſulphuret, in which the tin is oxyded to the minimum. This muriate requires a ſtronger heat for its diſtillation, than the ſmoking muriate in the ordinary proceſs.

But that ſubſtance which riſes, and is condenſed in the neck of the retorts, proves, afte waſhing, and ſeparating the fuming muriate, to be nothing but tin half oxyded, to which aci only need be added, in order to diſſolve it again. This diſtilled muriate effectually decompoſe the ſublimate of mercury, and all the mercurial preparations, or oxydes; while the fumin muriate, being oxyded to the maximum, decompoſes nothing.

The muriate of tin affords, with alcalis, a precipitate, which cauſtic pot-aſh abundantly di ſolves. This ſolution reſerved, in a cloſe veſſel, at the end of 12 or 15 days, affords a metalli group, in the form of cauliflowers, which conſiſts of tin, nearly pure. In this proceſs, on part of the tin, oxyded to the mininum, robs the other, and becomes ſaturated; and this mu riate of tin, ſo ſaturated, is no longer capable of altering corroſive ſublimate.

The ſame thing happens, if a mixture of the carbonate of copper, and the oxyde of tin, ſe parated from the muriate by pot-aſh, be kept under water. The oxyde of tin robs all th copper of its oxygen, and the portion of carbonic acid; whence the copper is found reduce in cryſtalized plates, among the oxyde of tin.

Laſtly, the muriate of tin diſoxygenates indigo, and changes it to green. This experimen is analogous to other diſoxygenations of the ſame fecula, known to dyers. Prouſt mention this circumſtance as an object deſerving of great attention, upon which he means to mak further reſearches.

The ſulphates, nitrates, muriates, acetates, and carbonates, of copper, and alſo, the re blue, or green oxydes, mixed with the muriate of tin, are generally converted into a whit oxyde, which is collected at the bottom of the veſſel; and if this muriate be paſſed again upo a new oxyde, it becomes itſelf green, and is ſaturated to ſuch a degree as no longer to alter the colour of oxydes. The powder, thus robbed by the muriate of tin, aſſumes differ ent ſhades of colours, violet, blue, black, &c. which are more particularly governed by th degre

degree of expofure to light. It is fufible by heat, and affumes the appearance of a muriate of filver, in which ftate Prouft propofes to keep it.

The fulphuric acid has no action on this fubftance, but the muriatic acid immediately diffolves it, and it cryftallizes in tetrahedrons. The nitric acid alfo diffolves it, during which it paffes through various fhades of colour; but at laft it retains the appearance of a folution of nitrate of copper, in which the prefence of muriatic acid may be eafily detected. But the difengagement of nitrous gas which takes place during the folution, proves that it is not faturated with oxygen.

Prouft, obferving that this muriate was without colour, and that it was alfo foluble in ammoniac without colouring it, thought at firft that he might conclude, contrary to the principle eftablifhed by Lavoifier, that the copper was abfolutely clear of oxygen; but the analyfis which he made foon undeceived him.

He diffolved 100 grains of this white fufed muriate in very pure nitric acid, which he afterwards precipitated by the nitrate of filver, and obtained 142 grains of muriate of filver, which reprefent $24\frac{3}{4}$ grains of marine acid. On the other hand, 100 grains of very white muriate of filver treated with nitric acid, and carbonate of pot-afh, afforded him 113 grains of carbonate of copper, which, according to experiment, anfwer to $62\frac{7}{9}$, or 63 of copper, fo that from his analyfis he found thefe products:—marine acid $24\frac{3}{4}$; oxyde of tin 1; copper 63; and the $11\frac{1}{3}$ deficiency remain for oxygen.

Whereas he was fatisfied, that in the green muriate, in the fulphate, in the nitrate, and in the acitite of copper, the metal which is at the maximum of oxygenation, contains about 26 of oxygen in the centenary.

Laftly, it is proved that while the copper is oxyded no farther than 17 or 18, its folutions are white, and it cannot then give colour either to its muriate, or to ammoniac.

The following, as Prouft informs us, is another proof of the prefence of oxygen in this white powder. If a fmall quantity be put into water with iron filings, the copper foon feparates, and the iron becomes oxyded to the minimum, fo that when diffolved the alcalies precipitate it of a green colour.

If it be demanded whence the oxygen comes in the white folution of copper in the muriatic acid, Prouft replies, that it is from the water. The water is decompofed, as Berthollet had before fhewn. The oxygen combines, and oxydes the copper. Prouft even relates an experiment in which the hydrogene of the water was rendered perceptible to the fmell, by the affiftance of a fmall quantity of fulphur which was formed, and was diffolved and volatilized with the hydrogene. This experiment confifts in boiling the blue fulphate of copper in muriatic acid. A folution is obtained, which is precipitated by water, during which the hydrogene becomes perceptible to the fmell.

When a green muriate is diftilled, it may eafily be brought to the point of cryftallization; but if the diftillation be carried further, it is decompofed, and lofes the portion of oxygen, which makes the difference between the oxyde containing 25 parts, and that containing only 18; but the diftillation then affords oxygenated muriatic gas. At length this gas ceafes, and there remains at the bottom of the retort a grey, well-fufed mafs, which is the white muriate of copper. This is an eafy method of procuring the white muriate. Prouft adds, that

that the copper in the green fand of Peru, and in the native muriate of Chili, are in this ftate.

It is of importance to remark, that the chemift might be induced to believe, that when a metallic fubftance is difoxygenated in any manner whatever, whether by the application of ftrong heat, or by the affinities of other metals for oxygen; or, in the manner of Prouft, by hepatic gas, as happens in the difoxygenation of the tunftic and molybdic acids; the chemift might think, that thefe fubftances, at their tranfition to the violet blue, or black colour, were reduced to the metallic ftate: but the effect is, as he remarks, merely an incomplete difoxygenation. The metal is merely depreffed to the minimum, as happens with iron and copper, when by various means they are brought from their entire ftate of oxygenation, to that in which the colour becomes blue, black, or red, more or lefs deep. There are no metals but mercury, gold, and arfenic, in which a complete difoxygenation is obferved.

But to return to tin: Prouft has found, with Bergman, that tin oxyded to the minimum acquired no more than an addition of 30 parts in the hundred, and even in this ftate is not exempt from marine acid. If it be ignited in a crucible it lofes weight, and emits the vapours of muriate of tin; and when the tin is oxyded to the maximum it is charged with 40 per cent. But it is eafy to reduce it 30, in which ftate it is blueifh, and infoluble in acids. The author here terminates his memoir, by remarking, that although Pelletier has not mentioned the white muriate of copper, he is not lefs perfuaded that it was known to that chemift; and this more particularly, becaufe he has fpoken flightly of the difoxydation of that metal by tin, as if he meant to fpeak more fully on another occafion. But while he renders this juftice to Pelletier, he affirms with the open freedom of truth, that though his refults coincide with thofe of that chemift, they were not undertaken fubfequent to his experiments.

There are a great number of other facts and obfervations in the Memoir of Prouft which deferve to be related; but the abundance and denfity of thefe facts are fuch, that the attempt to communicate them would convert this abridgement into a memoir no lefs ample than the original.

XV.

*Obfervations on the Differences which exift between the Acetous and Acetic Acids. By J. A. Chaptal.**

THE acid of four wine prefents to our obfervation two very diftinct ftates, which are known by the names of the acetous and the acetic acids.

Chemifts have hitherto referred this difference to the varying proportion between the oxygen and the radical, and it has generally been believed, that the acetic acid differs from the acetous fimply in a ftronger dofe of the acidifying principle†.

Citizen Adet has refumed this interefting refearch, and has prefented to the fociety a courfe of experiments, from which he concludes:

* Annales de Chimie, XXVIII. 113.

† We may except Citizen Perès, who, in the Journal des Pharmaciens, has announced, that the difference between the acetous and acetic acids confifts in the proportion of carbone.—C.

1. That

1. That no such thing as the acetous acid exists.

2. That the acid of vinegar is always at the highest possible degree of oxygenation; and, consequently, is always acetic.

3. That the difference between the acid obtained by the distillation of vinegar, and that afforded by the like process from the acetate of copper, depends on the less quantity of water contained in the latter.

I must confess, that notwithstanding the high degree of confidence I place in the labours of Citizen Adet, it has been impossible for me to adopt his conclusions in this respect; and as I was very far from calling his experiments in question, I have thought it proper to analyse, compare, and discuss, his results, much less with the view of ascertaining their accuracy, than to determine whether they justify the consequences deduced from them by their author.

I conclude, therefore, immediately with Citizen Adet, that it appears to be demonstrated by his experiments, that the oxygen exists nearly in equal proportions in the distilled acetous acid and the acetic acid; that it is equally difficult, and even impossible, to oxygenate the acetous acid, and to disoyxgenate the acetic; and that most of the salt separately formed by these two acids are of the same nature. These consequences, no less new than interesting, belong to Citizen Adet, and naturally flow from his experiments.

But to conclude, from the same facts, that the acetous and the acetic acids are exactly the same, and differ only in their proportions of water, is more than the experiments will justify; and while we must agree with *Citizen Adet as to the truth of his first consequences*, it may also be shewn, that there is a very great difference between the acetous distilled acid, and the acetic. I shall endeavour to ascertain the cause of this difference.

The two acids in question differ, no doubt, in smell, in taste, and solvent power; but as the cause of these differences might be referred to their respective degrees of concentration, I have thought it proper to bring both to the same specific gravity, by diluting the acetic acid with a sufficient quantity of distilled water; and it was with these two acids, at the same degree, that I made the following observations and experiments:

1. The smell and taste shew the difference between these two acids. The effects, in this respect, are more evident, and the sensation is much more penetrating on the part of the acetic than the acetous acid.

2. The action of the acetic acid on the lips, and upon the metallic oxydes, is more speedy and energetic than that of the acetous acid. These two acids, set to digest in equal portions upon the oxyde of copper, precipitated from the sulphate by pot-ash, washed, and then distilled, presented very different results. The acetic acid dissolved the oxyde, and formed beautiful crystals by cooling; but the acetous was simply coloured of a blueish green, and let fall nothing but a green saline crust, on the borders of the fluid.

Neither of these acids perceptibly attacked copper. They merely acquired, by long digestion, a light green shade of colour.

Eleven parts of the acetic acid required for their saturation 6,98 of pure pot-ash; the same quantity of acetous acid required only 5,73.

There, consequently, exists a difference between these oxydes. The following experiments will shew in what this difference consists, and render us acquainted with its cause:

I. If

I. If ſulphuric acid be poured on the concentrated acetic acid, and then diſtilled, the firſt conſequence is the production of conſiderable heat, the colour of the mixture becomes red, and increaſes in intenſity, until at length it becomes black. A great quantity of carbone is precipitated by the continued action of the heat, at the ſame time that much ſulphureous gas is diſengaged.

II. I put ſeparately into two glaſs retorts equal parts of the acetic and acetous acids, at the ſame degree of concentration; I poured upon each one-fourth of its weight of ſulphuric acid. This mixture produced a very ſtrong heat.

The colour of the mixture of ſulphuric acid with the acetic acid at firſt appeared of a pale yellow, while that of the acetous acid did not change colour.

The mixture of acetous acid arrived at the point of ebullition ſooner than the other. It became yellow after the evaporation of one-third of the fluid, and its colour grew deeper and deeper, until it had acquired the tinge of highly-coloured wine.

The mixture of the acetic acid was not coloured in the ſame proportion, and it never acquired a deeper tinge than that of ſtraw-coloured white wine.

The diſtillation being long kept up, and urged by a ſtrong fire, cauſed copious white vapours of ſulphureous acid to paſs over; and towards the end the two reſidues became colourleſs, and contained nothing but the concentrated ſulphuric acid.

The two firſt third parts of the product of the diſtillation had nearly the ſame ſmell and taſte, and the acetous acid appeared to me to have been brought to the ſtate of acetic acid by its decarbonization in the retort.

III. I ſaturated, with pure pot-aſh, 100 pots of each of theſe two acids, and put the ſolution to evaporate, and obtained, from both, white foliated deliqueſcent ſalts. I put equal parts of each of theſe ſalts into two retorts, and expoſed them to an equal heat, which was gradually increaſed till it became violent. There paſſed at firſt into the receiver of the apparatus in which the acetate was placed, two or three drops of offenſive ſmelling acid water, which indicated no acidity to the taſte. The diſtillation of the acetite produced nothing but certain vapours, which emitted a ſimilar odour.

The ſalt was firſt liquified, and then became black, in both the retorts. In proportion as I increaſed the heat, the retorts and receivers became lined with a white fume, which afterwards diſappeared.

In both retorts were left black reſidues, upon which I poured boiling diſtilled water. I waſhed them ſeveral times, in order to deprive them of all ſoluble matter.

Theſe reſidues being dried, preſented all the characters of carbone. Their weight compared with that in ſalt made uſe of, afforded the following reſults:

The acetate afforded one-ſeventeenth part of its weight in carbone.

The acetite afforded one-thirteenth part.

There is, conſequently, a difference between the acetous and the acetic acids; and this difference ariſes from the greater proportion of carbone in the acetous beyond that in the acetic acid.

It appears to me, that the phenomena preſented by the diſtillation of the acetite of copper, ought to lead us to the ſame conſequence. In fact, the acetite of copper is merely a ſolution of

of the oxyde of copper in the acetous acid, and when this ſalt is diſtilled, the acetous acid is decarbonated. Part of the carbone combines with the oxygen of the oxyde of copper, and eſcapes in the form of carbonic acid; while the other part remains in its ſolid form in the retort along with the oxyde itſelf. The acetous acid, thus deprived of a portion of its carbone, paſſes into the receiver with characters which no longer appertain to the acetous acid, and the oxyde of copper is nearly reduced to the metallic ſtate.

The acetous does not therefore become acetic acid, but by a ſubtraction of carbone. It appears that the metallic oxydes alone, and ſome of the acids, are capable of effecting this decompoſition.

The acid appears, therefore, to exiſt in the ſtate of acetous acid in the ſalt of copper, improperly called acetite. It does not become acetic acid but by diſtillation, becauſe it is by this proceſs only that it loſes a portion of its carbone.

Independent of the proofs we have exhibited in ſupport of this truth, we may adduce the two following facts:

1. When verdigreaſe is manufactured with the diſtilled acetous acid of copper, a pure ſalt is obtained, which affords by diſtillation the ſame products as the cryſtals of Venus, or the acetate of copper. I have mentioned this fact in a memoir concerning the compound proceſſes of the fabrication of verdigreaſe. 2. Every one knows that vinegar is ſo much the ſtronger, and more completely approaches in its ſmell to the acetic acid, in proportion as it is more completely deprived of the extractive matter with which it was combined. We may, in this caſe, conſider the acid of vinegar as originally exiſting in a ſtate nearly ſaponaceous, which diminiſhes its action, and weakens its properties. It is diſengaged from this addition, 1. by ſimple repoſe, which ſuffers part of the extractive matter to precipitate, or fall down; 2. by the ſulphuric acid, which decompoſes and more completely carbonizes the extractive matter; 3. by the oxyde of copper, which retains a portion of the ſame principle with which it appears to form a pyrophoric combination.

I was deſirous of aſcertaining whether the acetic acid could be brought back to the ſtate of acetous acid, by cauſing it to reſume, in the courſe of diſtillation upon carbone, that portion which it had loſt: but all the methods I made uſe of to ſucceed in this reſpect were ineffectual.

From the preceding facts I conclude: 1. That there is a difference between the acetous and the acetic acids. 2. That this difference ariſes from a ſmaller proportion of carbone in the acetic acids, than in the acetous. 3. That the acid is in the acetous ſtate in metallic ſalts. 4. That it does not paſs to the acetic ſtate but by decarbonization. 5. That the difference between this acid and ſome others, equally ſuſceptible of modifications by a change in the preparation of their conſtituent parts, is, that in this the oxygen does not appear ſuſceptible of addition, or ſubtraction; but its carbone alone undergoes which variation, and determines all its changes; whereas in the other acids the oxygen is the principle which is more particularly ſubject to variation, and occaſions the changes obſervable in their properties.

SCIENTIFIC

SCIENTIFIC NEWS, AND ACCOUNT OF BOOKS.

Lantern Pinions of Glass for Mill-work.

CITIZEN MOLARD has communicated to the French Institute an account of the advantages of making the trundles in lantern pinions of glass, to work against the hard wooden teeth of wheels in mill-work. The trundles are set in the same manner as those of iron, only taking the necessary care which the nature of the material must require. A pinion of this kind, in which the trundles were two inches in diameter, did not undergo the least wear, or alteration of the surface of the glass, in 18 months' use; and the wooden teeth had lost about one-twelfth part of an inch. Iron trundles wear out the teeth in about four months; and load the work with much more friction. The kinds of glass which were tried, were green window-glass, white sheet-glass, and the white glass for goblets (*gobeleterie*). This last was the hardest and best. The inventor, Cit. Renaut, of the department of La Meurthe, thinks bottle-glass might be of good service. He does not blow the trundles, but casts them solid. It is probable, that with us the glass of wine bottles might be the cheapest, and most valuable for its hardness and tenacity, if it can be easily wrought to the figure by the workmen who are employed upon it.—*Decade Philos. No.* 5, *Year* VII.

Institute of the Ligurian Republic.

THE lately established Institute of the Ligurian Republic is composed of 72 members, of which 36 are resident, and 36 associates, inhabitants of the republic, divided into two classes, and each of these into three sections.

The first is the class of mathematical and physical sciences, of which the three sections are: 1. Agriculture, commerce, and manufactures. 2. Nautical science, mathematics, natural philosophy, and natural history. 3. Chemistry, botany, anatomy, medicine, and surgery.

The second class includes (moral) philosophy, literature, and the fine arts, of which the sections are: 1. The art of reasoning, and analysis of the operations of the understanding, grammar, eloquence, and poetry. 2. Politics, history, and antiquities. 3. Arts of design.

On the 14th Brumaire (Nov. 4) the Executive Directory of the Republic repaired to the Hall of Session of the Institute, and the establishment was opened by the formality of proclaiming the members, &c. after which the Institute proceeded to choose their president and secretaries, and to organize their future labours.

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*Institute of Cairo.**

THE learned men who accompanied Buonaparte in his expedition have formed a national Institute at Cairo, composed of four classes, each consisting of twelve members. They hold their meetings on the first and sixth day of each decade.

The names of the members of each class are as under:

Class I. Mathematics. Andréossy, Buonaparte, Costaz, Fourier, Ge[illegible]ard, Lepére, Leroi, Malus, Monge, Nouette, Quesnot, Say.

* From the Magazin Encyclopedique, IV. 552. Nivose VI.

Class

Class II. Natural Philosophy. Beauchamp, Berthollet, Champi, Conté, Delisle, Descotils, Desgenettes, Dolomieu, Dubois, Geoffroy, Savigny. (There is one place vacant.)

Class III. Political Economy. Caffarelli-Dufalga, Gloutier, Poussielgue, Sulkowsky, Sucy, Tallien. (Six places vacant.)

Class IV. Literature and the Arts. Denon, Dutertre, Nery, Parceval, Redouté, Riegel, Venturi, Raphael, a Greek priest. (Four places vacant.)

On the 6th Fructidor, in the year VI. (Aug. 23, 1798), at seven in the morning, the Institute of Egypt held its first sitting, at which Buonaparte presided. The officers were elected: Monge, president; Buonaparte, vice-president; and Fourier, perpetual secretary; in whose place, on account of his absence at Rosetta, Costaz was provisionally appointed.

In this first sitting Buonaparte made the following propositions:

1. *What are the best methods of improving the construction of ovens to bake bread for the army?* The commissaries named to examine this question were, Berthollet, Caffarelli, Say, and Monge.

2. *What product can be substituted instead of hops in making beer?* Commissaries, Berthollet, Malus, Costaz, Gloutier, and Desgenettes.

3. *How may the waters of the Nile be clarified, and rendered pure?* Commissaries, Monge, Berthollet, Costaz, and Venturi.

4. *Are wind, or water mills, to be preferred? (in the present circumstances).* Commissaries, Caffarelli, Malus, Say, and Costaz.

5. *What are the resources for procuring gunpowder?* Commissaries, Andréossy, Malus, and Venturi.

6. *What is the state of legislation in Egypt, and how can it be meliorated?* Commissaries, Say, Sulkowsky, Tallien, and Costaz.

7. *A project of regulation (of the Institute?)* Commissaries, Monge, Caffarelli, Tallien, Geoffroy, Costaz.

(To be continued).

Cases of the Diabetes Mellitus, with the Results of the Trials of certain Acids, and other Substances, in the Cure of the Lues Venerea. By JOHN ROLLO, Surgeon-General, Royal Artillery. Second Edition, with large Additions.

THE second edition of this treatise was announced at p. 427 of the present volume, but time did not then permit me to give an account of the additions and facts now first published. The additional cases and communications on this diabetes, appear to establish the author's opinion respecting the efficacy of diet consisting entirely of animal food, when rigorously persevered in. The dissections likewise prove, that the sweet urine does not proceed from any organic affection of the kidneys, but most probably from some vitiated state of the stomach, and organs of digestion.

The additional cases are, two from Dr. Gerard of Liverpool; a continuation of Walker's case, by Dr. De la Rive; four from Dr. Cleghorn of Glasgow, with a continuation of his former cases; some remarks and cases by Dr. Storer of Nottingham, with a continuation of Dr. Aldrich's case; one from Dr. Jameson, surgeon of the Royal Artillery; one from Mr. Sherriff

Sherriff of Deptford; one from Mr. Houften of London; three from Dr. Pearfon of St. George's Hofpital, with remarks; one from Dr. Marfhall, with the diffection; one from Dr. Willan; and one from Mr. Thomas of Leicefter-fquare, with the diffection.

Dr. Rollo informs us, that, fince the firft difperfion of his notes on Capt. Meredith's cafe, in Jan. 1797, the number of diabetic patients, which he has either feen or heard of, amounts in all to 48; a circumftance which proves, that this complaint has been frequently overlooked, and is by no means fo rare as has been generally fuppofed. At the end of the firft part are fome experiments and obfervations on urine and fugar, by Mr. Cruickfhank.

In the fecond part, we find a continuation of the trials of the nitrous acid, and other oxygenating remedies, in the lues venerea; which appear to eftablifh their efficacy in this difeafe, both in its primary, and fecondary ftages. The number of cafes cured in this way, fince March 1797, amount to 155; of thefe, 59 were cured by the nitrous acid; 59 by the oxygenated muriate of pot-afh; 7 by the oxygenated muriatic acid, and muriate of manganefe; 3 by lemon juice; 11 by the nitrous and other acids, combined with the oxygenated muriate of pot-afh; and 16 by a combination of mercury, with the new remedies.

In a few inftances, where thefe medicines had not been continued for a fufficient length of time, relapfes occurred, and the fecondary fymptoms made their appearance; but all thefe were afterwards completely cured, by perfevering in the fame mode of treatment.

At the conclufion of this part are fome ufeful and neceffary obfervations, with regard to the management of thefe remedies, more efpecially the oxymuriate of pot-afh: but for particulars, the reader muft refer to the work itfelf; of the character and importance of which, the public is fufficiently aware.

Moyens d'apprendre à compter furement et avec facilité, ouvrage pofthume de Condorcet; or, Methods of learning Accounts with certainty and eafe. One volume, 8vo. 132 pages. Sold by Maulardier at Paris, year VII.

The diftinguifhing character of thefe elements, fays the editor, are, that they exhibit the elements of arithmetic and logic at the fame time. The author ufes the decimal fyftem. Mag. Encycl.

Mr. Lowry, engraver, of Titchfield-ftreet, the artift alluded to at page 429 of the prefent volume, has fhewn me his machine for ruling, which is very different from mine, in all its parts. As he has no actual divifion in the part which produces the fhift, he can regulate his diftances to incommenfurate, as well as commenfurate, meafures. The parallax of the ruling point, againft which I had made no provifion, is, by a very fimple and happy contrivance, taken away in common ruling, or rendered variable at pleafure, for the purpofe of thickening the ftroke in fhading. This, together with his great profeffional fkill and fcience, has given Mr. Lowry's engravings the degree of precifion and effect for which they are fo juftly admired.

In July 1786, I communicated to the celebrated Mr. Troughton, of Fleet-ftreet, a fmall apparatus, for fecuring the point from lateral deviation, in dividing mathematical inftruments, which I did not think neceffary to add to the inftrument in plate 20.—The execution of that plate, in which the point was left to the ufual management of the artift, fhews, however, that fuch a contrivance is neceffary, and I fhall take an opportunity of defcribing it hereafter.

Air Pump by the Rev. James Little.

Fig. 4.

Fig. 5.

Fig. 3.

Fig. 1.

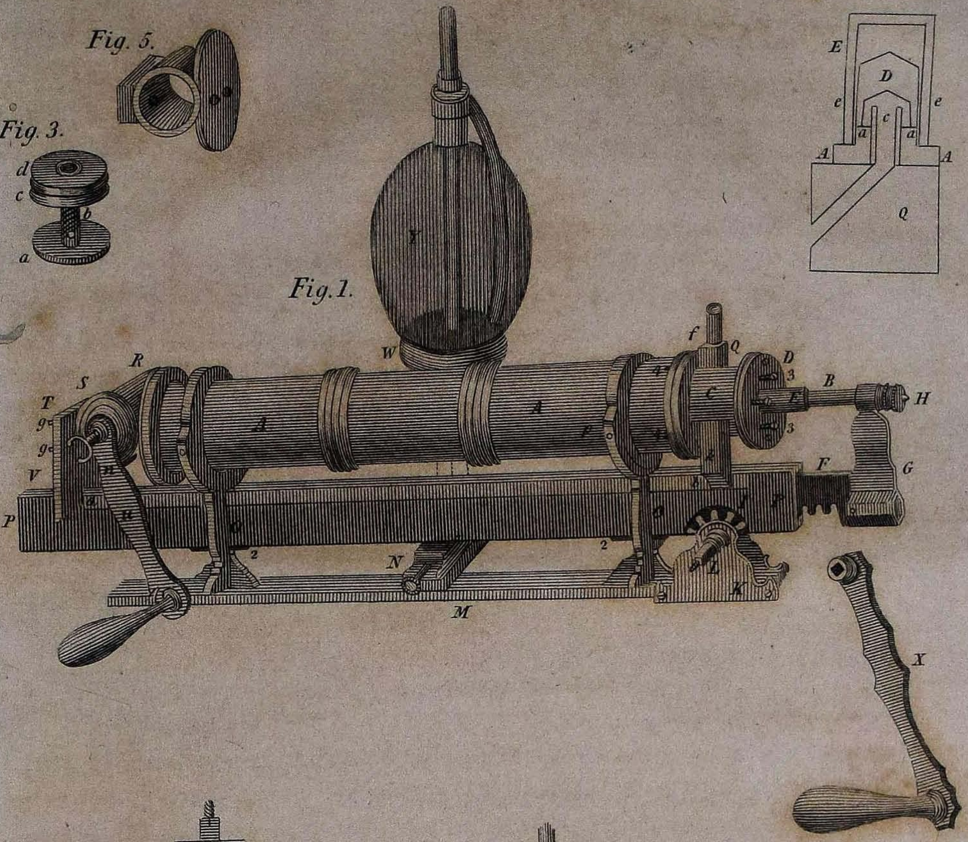


Fig. 7.

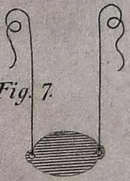
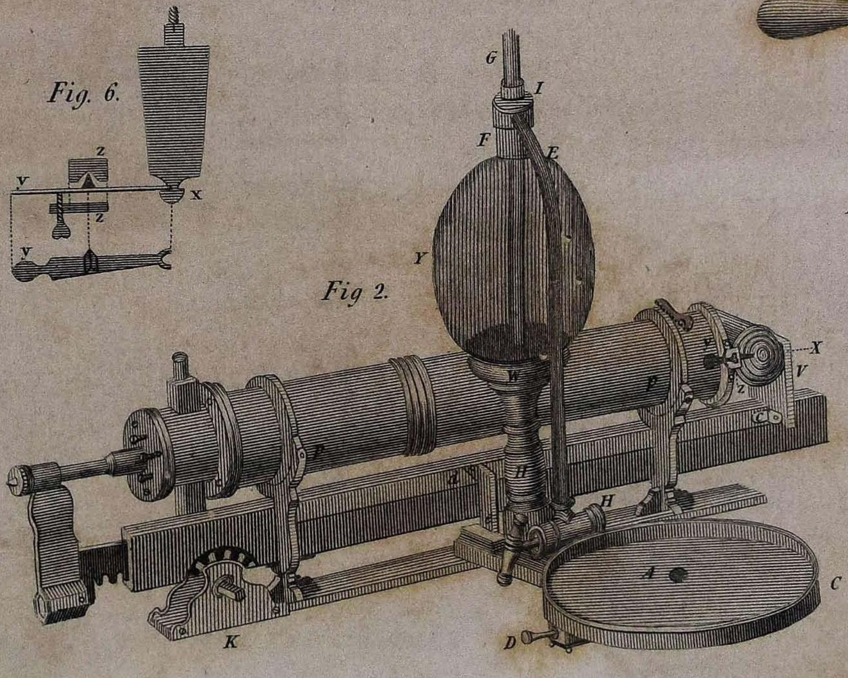


Fig. 6.

Fig 2.



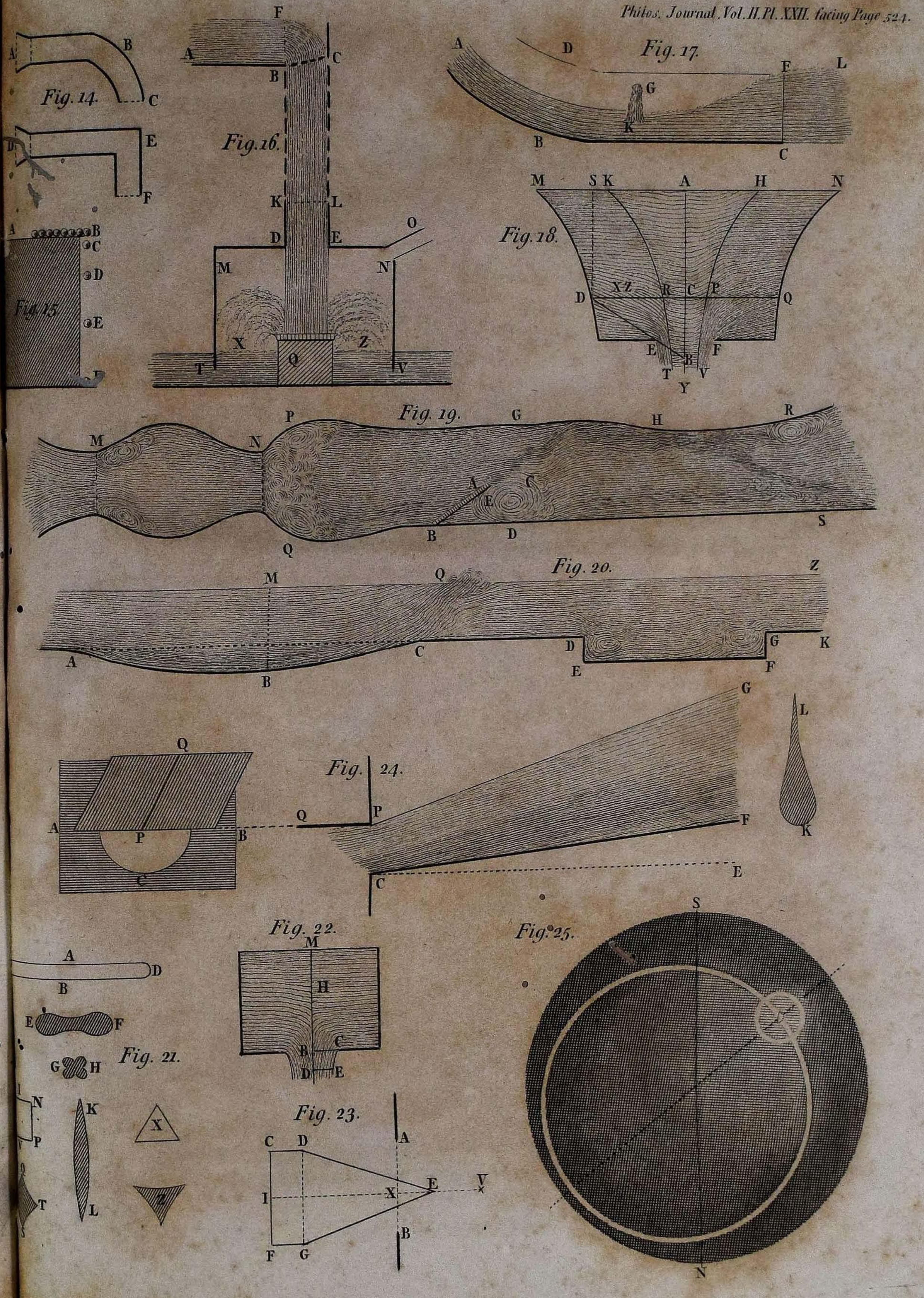


Fig. 14.
A B C
D E F
Fig. 15
A B C D E
Fig. 16.
F A C B K L D E M N O X Z Q T V
Fig. 17.
A D F L G K B C
Fig. 18.
M S K A H N
D XZ R C P Q
E B F T V Y
Fig. 19.
P G H R M N A C E B D Q S
Fig. 20.
M Q Z A B C D G K E F
Fig. 24.
Q P A B C G F L K E
Fig. 22.
M H B C D E
Fig. 21.
A B D E F G H I N P K L X Z T
Fig. 23.
C D A I X E V F G B
Fig. 25.
S N